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Studies on the Rays and Skates Belonging to the
Family *RAJIDAE*, Found in Japan and Adjacent Regions

4. A Revision of Three Genera of Japanese Rajids,
with Descriptions of One New Genus and
Four New Species Mostly Occured
in Northern Japan *)

By

Reizo ISHIYAMA

With 4 Plates and 7 Text-figures.

During the course of the present study, the writer has been able to examine a large number of specimens involving many interesting forms. These are represented by twentyfour species, which slightly exceed twice the hitherto known Japanese species. Of these, several one are recognized as new to science.

All the rajid-fishes of Japan and adjacent regions have hitherto been referred to a single genus *Raja*, whilst in the present study, the writer splited it into three genera, *Raja*, *Breviraja* and *Rhinoraja*, the last of which is proposed herein as new.

The present instalment deals with the revisional study of Japanese genera of rajids together with descriptions of a new genus and four new species principally found in northern Japan.

The classification of rajids have usually been done on the basis of the external characters. But, it appears that such taxonomic studies are not sufficient not only for the complete separation of the species but also for setting up the generic criterions.

Such being the case, the present study was made based mainly upon the characters such as the rostral cartilage, cranium, counts of both vertebrae and turns of intestinal valve, and egg-capsules, in addition to the external characters.

Although the characteristics of rostral cartilages in *Elasmobranchii* have been discussed in many works, the detailed analytical investiga-

* Contribution from the Zoological Laboratory, Shimonoseki College of Fisheries,
No. 14

tions have not yet been taken into taxonomy so far as our knowledge on the rajids is concerned.

Quite recently, very interesting taxonomic studies of the Atlantic rajids has done by BIGELOW and SCHROEDER (1948, 1950) on the basis of the comparative studies of the rostral cartilage. In these works, they have referred six genera under the present Family. Of these, two genera, *Breviraja* and *Cruriraja*, were newly erected from the results of osteological observations that merely taken with the roentogen photographs but without giving any anatomical examinations of the rostral cartilages or the pelvic cartilage comparing with other known genera. The application of roentogenograms is often useful for the ichthyology or applied fishery biology without elaborations as already pointed out by Gosline (1948).

However, it appears that the method has some difficulties to clear out the osteological differences depicting the bony structure. As a matter of fact, the roentogen photographs in the present study showed the marked differences against the results of anatomical investigations, despite of these photographs appeared to have come out as sufficient as that of BIGELOW and SCHROEDER's ones (1948, Fig. 1). And, moreover, by the present technics of the photographs could not take even the presence of the rostral cartilage, especially when the species being the delicate cartilage covered by the tough skin (Fig. 1 A, A'-C, C').

Accordingly, it should be mentioned that the roentogenograms for the ichthyological studies are apt to give the cause of the erroneous conclusion, especially so when it was taken into the osteological examinations intended to set up the systematic basis. Wherefore, the present investigation of the rostral cartilages was taken place by the tedious anatomical method or histological study.

On the other hand, as for the vertebral counting, the application of roentogenograms was employed as a reliable method due to the heavy calcification segmenting obvious centrums, although they bear of much uncertainty for counting their posterior extremities owing to the incomplete segmentation. The writer, therefore, gave the vertebral count before the origin of 1st dorsal fin by roentogen photograph, but the rests were measured anatomically. Thus, the writer compared the counts of vertebrae split into three groups, the abdominal, precaudal and procaudal vertebrae, as explained later on.

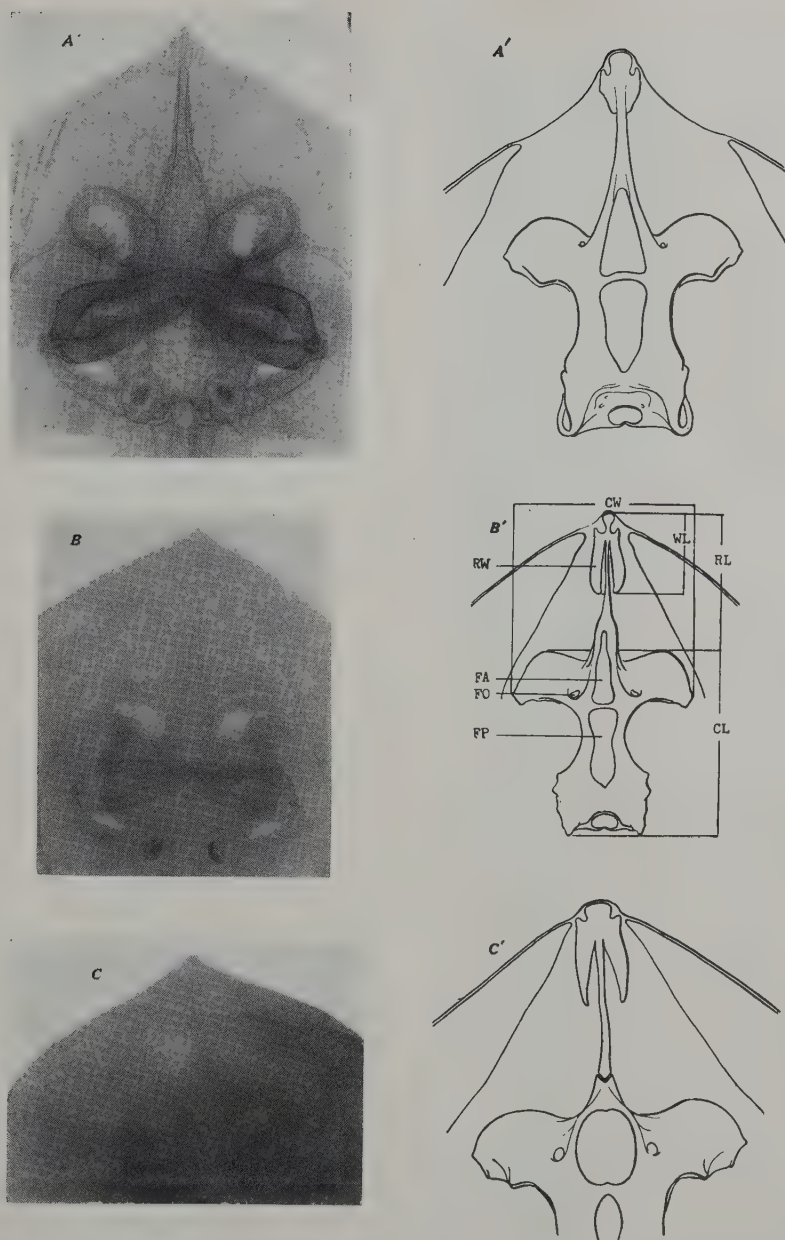


Fig. 1. Showing three types of rostral cartilage of Japanese rajids compared with their X-ray photographs (A-C) against anatomical views (A'-C'), and parts of cranium and rostral cartilage on which measurements were made (B'), see also explanation of p. 5. A, A', *Raja fusca*; B, B', *Breviraja tobitukai*; C, C', *Rhinoraja kujiensis*. All these photographs are not retouched, and unsatisfactory depicting the real structures of the cartilages, especially in C against C'. FA, anterior fontanelle; FO, foramen for superficial ophthalmic nerve; FP, posterior fontanelle; RW, rostral wing or appendix..



Fig. 2. X-ray photographs of the vertebrae in our rajids, showing two types in number and method of counting in the subdividing groups. A, *Raja kenoi*. B, *Brevitaja isorhynchus*. Black pin-heads denote the anterior corner of cloaca and insertion of 1st dorsal fin respectively; white ones indicate the boundary between abdominal vertebrae and precaudal ones.

Then, the most considerable differences in number of vertebrae of our rajids were noticed to exist in the precaudal series that may be used for the separation of this group above the rank of species, though the same trends was recognized as in the case of total number of vertebrae (Fig. 2).

It appears with some difficulties that we find the way to subdivide the caudal groups of vertebrae into two parts as mentioned above or will be given later on, but, with regard to the consideration in question, the present writer wishes to reserve for the future works^{*)}.

In short, the count of the precaudal vertebrae is fewer in *Raja* than in either *Breviraja* or *Rhinoraja*, being 36 to 37 instead of 63 to 89 in the latters.

Thus, the remarkable differences of the vertebral counts that are found to exist will enable us to separate the Japanese rajids into some phyletic groups, although the counts are not always useful for the separation of genera or species as given by some authors. But, it would be very worthy mentioning that these two groups of our skates or rays — the species belonging to genus *Raja* and those referred to two genera *Breviraja* and *Rhinoraja* — are so obviously set apart each other by the well defined rostral cartilages in addition to the remarkable difference in the vertebral counts.

The other important characters such as the anatomical characters of claspers and the arrangement of valves of conus arteriosus are supposed to be useful for the classification as well as for the phyletic significance.

Of this matter, however, is deferred in detail to the forthcoming issues.

The writer must express his cordial thanks to Dr. Kiyomatsu MATSUBARA, Professor of Kyoto University, who offered a kind guidance in many ways and placed his valuable specimens at the writers disposal. Also, the heartfelt thanks are extended to Mr. Ryozi ICHII, technical expert of Maizuru Municipal Hospital, by whom the many X-ray photographs for the present investigation were made; and other photographs were taken by Mr. Sueo HARADA, of our College. About the collection of materials especially in Hokkaido District, the author wishes to express his warmest thanks to Dr. Toraichiro KINOSHITA and the

* On the systematic relative length of the tail in relation to the number of vertebrae is deferred to another paper.

officials of Hokkaido Regional Fisheries Laboratory, and Dr. Yoshiteru NAKAMURA, Assistant Professor of the Institute of Muroran Algological Research, Faculty of Science, Hokkaido University. Further more, many thanks are due to technical officials of the Tōhoku Regional Fisheries Laboratory, Hachinohe Branch, and Yoshimitsu TANAKA, the chief technician of Nitiro Fisheries Co., Monbetus Branch, Hokkaido. The expense for excuting the work was partly defrayed by research fund from Ministry of Education granted to the author in 1950 and to Dr. K. MATSUBARA in 1951.

Materials and method of study

The present study is made on 2 genera and 10 species which may constitute almost all the members of our northern forms characterized by having the soft snout, and they were chiefly obtained from the deep-seas. But, two of these in the genus *Breviraja* were collected from the middle part of Japan. The following table includes these fishes, showing the number of specimens and their localities, etc.

Table 1. Localities, number of specimens, and depth of collection (fathoms). A, *Breviraja tobitukai*; B, *B. isotrachys*; C, *B. aleutica*; D, *B. matsubarae*; E, *B. diplotaenia*; F, *B. abasiriensis*; G, *B. smirnovi*; H, *B. parmifera*; J, Japan Sea, K, *Rhinoraja kujiensis*; L, *R. longicauda*; O, Okhotsk Sea; P, Pacific; +, where the species nearly recognized; number of specimens for counting of vertebrae and intestinal valves were put in parenthesis.

Localities \ Species	A	B	C	D	E	F	G	H	K	L
Owase, Mie; P	6									
Maisaka, Shizuoka; //	2									
Chōsi, Chiba; //					2				2	9
Shiogama, Miyagi; //		+	2		8				13	10
Same, Aomori; //		3	+	2	+				10	4
Muroran, Hokkaido; //		3	4	+	9			1	+	+
Kushiro, // ; //		3	9	16	12				2	2
Abasiri, // ; O		+	+			9				
Monbetsu, // ; //		9	2			1	17			
Wakkanai, // ; //		+					2			
Funakawa, Akita ; J		10					1			
Sado, Niigata ; //							4			
Maizuru, Kyoto ; //		3					4			
Oki, Shimane ; //		3					1			
Number of specimens	8(5)	34(5)	17(5)	18(5)	31(5)	10(5)	29(5)	1(1)	27(5)	25(5)
Depth captured (ca. fathoms)	200~ 300	150~ 250	80~ 450	400~ 500	150~ 300	80~ 100	70~ 250	?	300~ 400	300~ 400

First, for the description of external characters of the new species I used holotype, and later, the individual variations in both numerical and proportionate characters of each species in accordance with growth or in two sexes were clarified by the paratypes, but with regard to the anatomical or histological investigations of the fish or the egg-capsules were operated on 1 or 5 specimens.

The method of measuring and terminology in the external were followed to CLARK (1926, p.6, Fig. 1) in so far as not otherwise mentioned later on.

The tail was distinguished into two parts, thus: the distance from the cloaca to the origin of 1st dorsal fin was termed precaudal, and the rest was referred to procaudal one. To indicate the degree of notch in the ventral fin, the distance from the tip of anterior lobe to incised corner between two lobes was measured and termed it as ventral incision. The length of clasper was measured from the tip and its point of emergence from the skin on the inner side as stated by STEVEN (1934 : p.887).

To indicate the characteristics of the cranium in each form satisfactory, the measurement and terminology of various parts of this organ were standardized as follows (Figs. 1 B^h ; 2) :

1. The length of the rostral cartilage measured the vertical line between from the anterior tip and the tangential line of nasal capsules in two sides (RL in Fig. 1 B).

2. The length of rostral wing measured from the tip of rostral cartilage to horizontal line passing through the posterior ends of the wings (WL in Fig. 1 B).

3. In length of cranium rostral cartilage is excluded (CL in Fig. 1 B).

4. The width of cranium is measured at the broadest portion (CW in Fig. 1 B).

The vertebrae are subdivided into three groups, thus: abdominal precaudal and procaudal respectively; the abdominal ones were regarded to the ordinary locus of vertebrae; the precaudal followed by the procaudal ones were divided from the latter at just under the origin of 1st dorsal fin (Fig. 2). Of these, however, in this work, for the convenience in the descriptions of vertebral counts, the first two regions in the vertebrae were taken into the systematic constants, but the rests were kept out side owing to their uncertainness for the counting. Those

concerning the egg-capsules were done as in the case previously given by the present author (1950).

Key to Japanese Genera: (Internal characters are italicized).

- A. Snout with hard axis in touch bearing clear rostral ridge, that scarcely be bent in its base. Tail always much shorter than length of disc. *Rostral cartilage very short, projecting from skull in a rod- or tape-like bar, inserted by rostral appendices or wings at the anterior extremity of the cartilage. Posterior ends of the wings free from the rostral axis on no occasion. Anterior tip of radial cartilages of pectoral fins falling far from outer edges of the wings in lateral sides of rostrum, leaving large semicartilaginous portion in front of the skull* (Fig. 1 A). *Precaudal vertebrae relatively few, about 36 to 57. Egg-capsule belongs to Kenojei- or Pulchra-type*..... *Raja* LINNAEUS
- AA. Snout very soft and flexible without rostral ridge. Tail usually longer than or nearly equal to length of disc with some exceptions. *Rostral cartilage very feeble, developing from skull in slender tape- or bar-like projection, inserted by rostral appendices or wings and in preceding one, but the posterior ends of the wings apparently free from the rostral axis, hanging more or less posteriorly. Anterior edges of radial cartilage of pectoral fins very close near the appendices* (Fig. 1 B', C'). *Number of precaudal vertebrae numerous, 63 to 89. Egg-capsule belongs to Isotrachys- or Parmifera-type.*
- B. *Rostral cartilage without segment* (Fig. 1 B'). Tail usually almost equal to or slightly longer or shorter than length of disc. Egg-capsule belongs to *Isotrachys- or Parmifera- type* *Breviraja* BIGELOW and SCHROEDER.
- BB. *Rostral cartilage with a segment* (Fig. 1 C'). Tail always longer than length of disc. Egg-capsule belongs to *Isotrachys* or allied one..... *Rhinoraja*, gen. nov. p. 24.

Relationships: On the basis of the following two important characters, namely, a) feature of rostral cartilage, b) number of precaudal vertebrae in connection with the length of tail, the writer could attain to consider in Japanese rajids, it appears to be very reasonable to separate the evolutionary trend into two diversified series.

With regard to the rostral cartilages, the form referred to genus *Raja* may surely be interpreted to be more primitive than those of other two genera by having more fundamental feature, such as large rostral axis inserted by lower developed rostral wings which were supposed to be closely relating to those of the lower animals, Rhinobatidae (PARKER; 1879, GARMAN; 1913, WHITE; 1937, HOLMGREN; 1940, '41).

On the contrary, those of much reduced rostral cartilages and broadly developed rostral wings observed in other two genera are apparently

recognized as more advanced forms than those in genus *Raja*. Such phenomena of specialization and reduction found in the cartilages should have been offered to undergo the forward expansion of pectoral fins in the rostral region.

It should be noticed herewith that the highest specialization of the rostrum in our rajids is recognized in the genus *Rhinoraja*, which have a segment in the reduced rostral cartilage in addition to the large wings. Furthermore, it should be thought without any doubt that this type of rostrum must have diverged directly from that of the genus *Breviraja*.

On the other hand, for the reduction of vertebral counts in relation to the length of tail, the writer considers that the tail of the rajids must have been creating their evolutionary tendency to be to serve for the defensive or tactile organ being gradually undertaken its reduction in the tail which has regarded as the organ of movement, the original function in the elasmobranchs. The shorter length of tail with fewer number of vertebrae by which characterizing the tail in genus *Raja* is appeared to have resulted in the remarkable development of such organ, viz., the very sharp spines or the highly developed electric organ.

But, since other two genera being left the longer tail with larger number of vertebrae compared with those of former ones, their tails may be recognized that bearing more effective power for the movement of the body retaining more primitive state, though they also have poorly developing defensive organs in most cases.

Wherefore, we can see the reversed relationship between the specialization in the rostral cartilage and reduction of the tail within the groups of the fish diversing two representatives, *Raja*, and *Breviraja* and *Rhinoraja*.

The interspecific relationships in detail will be reported in other paper accompanying some other important characters supposed to be useful for the taxonomy and phylogeny of this group.

Breviraja BIGELOW and SCHROEDER, emend.

Breviraja BIGELOW and SCHROEDER, 1948, Jour. Mar. Reser. 7 (3) p. 558.

Type : *Breviraja colesi* BIGELOW and SCHROEDER, Atlantic.

External : Snout soft and flexible, forward extension of pectoral rays close nearly to the tip of snout on either sides; tail stout, rather

long, its dorsal border more or less roughened with spines or prickles; entire upper surface of disc or at least nuchal and orbital regions prickled.

Internal: — Rostral cartilage extends to tip of snout without any segments, its portion before the anterior fontanelle abruptly being reduced into a so weak or delicate bar that the X-ray can not sufficiently depict in the photographs (Fig. 1 A'-C'). Very thin translucent rostral appendices of the cartilage developed in preximal portion bearing three distinct small projections. Of these, the central one differs from others by having broad and flattened or domed apex instead of being pointed in other lateral ones. Shallowly or deeply notched between the former and the latter process. Posterior tips of the wings are free from the rostral bar, forming a pair of deep notches between the wings and rostral cartilage. Anterior tips of radial cartilags of pectoral fins usually close near the lateral edge of the wings, but the distance between them are found in considerable differences as specific ranks. Hence, the external feature in the preximal portions of the rostra are principally depend upon the degrees of development of the process and the relationships between the tips of pectoral radialias and the lateral wings.

Judging from the methods of examinations and the external features of the type described by the prior author, the rostral cartilage of the species which to be involved into the genus seem to me to be reaching the tip of snout with the cartilage as the case mentioned above.

Vertebrae about 100 to 130; spiral valves of intestine 5 to 13. Egg-capsule, *Isotrachys*- or *Parmifera*-type.

Key to the Japanese species of genus *Breviraja*: (Internal characters are italicized).

- A. Tail always shorter than half the total length of body; dorsal border of disc almost smooth with exceptions of sparsely prickled marginal portion, orbital rim and mid-belt of disc; nuchal and shoulder spines apparent; egg-capsule belongs *Parmifera*-type.
- B. A row of 2-4 large nuchal spines isolated from those of caudal ones; tip of snout bluntly pointed; *rostral wing very small less than a fourth the length of rostral cartilage*.....*B. smirnovi* (SOLDATOV and PAVLENKO)
- BB. Nuchal spines set in a single series run backward, joined to those of caudal series; distal end of snout roundly projected; *rostral wing rather long, about one-third times as long as rostral cartilage*.....*B. parmifera* (BEAN)
- AA. Tail commonly longer than half the length of total length of body; dorsal border of disc thickly armed with prickles or at least thorny in marginal portion, orbital

- rim and mid-belt of disc; egg-capsule, *Isotrachys*-type or its allied form.
- C. *Rostrla wing very long, hanging posteriorly, more than one-half times as long as rostral cartilage, disc shorter than tail.*
- D. Dorsal border of disc densely armed with prickles without any large spines; *precaudal vertebrae 63-66; intestinal valves 5-6*; body uniformly grey including both dorsal and under surfaces; smallest in this group, scarcely exceeds more than 500 mm in adult; inhabits deeps in the Pacific coast of middle of Honsyu (the main land)..... *B. tobitukai* (HIYAMA)
- DD. Dorsal surface of disc in adult largely smooth with exceptions of marginal region, orbital rim and mid-belt of disc covered with many prickles, but the entire surface is sparsely armed in young; nuchal spines 0-6 (mostly 3-6); shoulder unarmed with spine; *precaudal vertebrae 70-74; intestinal valves 11-12*; darkish purple in both surfaces; body large, extends more than 1000 mm in total length; inhabits very deeps, in the Pacific coast of northern Honsyu..... *B. matsubarae*, sp. nov., p.10.
- CC. *Rostral wings small, shorter than half the length of rostral cartilage; disc somewhat shorter or almost as long as tail.*
- E. Without large spine on shoulder, dorsal surface of disc almost smooth in adult, leaving prickles densely in marginal, orbital and mid-belt portion respectively, but in young thinly prickled on entire surface.
- F... Ventral fin deeply notched, the incision about 1.22-1.84 in snout; nuchal spines 0-3 (average, 0.35), caudal spines 18-28 (average, 22.25); ground color of dorsal surface uniformly faint rosy or dark chocolate, without any peculiar patterns; inhabits deeps in the Pacific coast of northern Honsyu *B. diplotaenia*, sp. nov., p. 15.
- FF. Ventral fin moderately notched; without nuchal spine; caudal spines sparsely set at places in a row, 0-15 (average, 8.2) in number; dorsal surface greyish brown, with irregular darker patterns; found in rather deeps of the Okhotsk Sea and the neighbouring waters *B. abasiriensis*, sp. nov., p.19.
- EE. Shoulder armed with 1-2 pairs of spines in most cases; disc uniformly prickled on dorsal surface even in adult.
- G. Nuchal spines 2-8 (3.62 in mean), isolated from those of caudal region; under surface of disc smooth and almost colorless; attains about 1000 mm in maximum; inhabits deep-seas, from middle of Honsyu to further north *B. isotrachys* (GÜNTHER)
- GG. Nuchal row of spines extend backward, joining with those of caudal region in most cases, the spines 34-40 in total; under surface covered with spinules or sometimes smooth; large black blotches present on under sides of disc and tail; body very large, attains about 1500 mm in total length; inhabits deeps from northern Honsyu to Alaska *B. aleutica* (GILBERT)

Breviraja matsubarae *) , sp. nov.

Pl. 1, Text-figs. 3-4

Holotype. — Ishiyama's Fish Coll. No. 16701 (1063mm, ♂, Pl. 1 A, Fig. 3 A), off Erimo Peninsura, Hokkaido, May 20, 1951.

Paratypes. — 17 specimens** (176-1165mm, Pl. 1 B, C), off Kushiro to Same, May to June, 1951; deep-seas.

Description: Disc length 2.15, width 1.64 and tail 1.79 into total length. Head 2.01, snout 5.70, precaudal length 1.09 and distance between tip of upper jaw and cloaca 1.35 into disc length. Snout 2.83, length of 1st, 2nd dorsal and caudal fins, 3.84, 4.03 and 5.60 into head respectively. Interorbital space 2.03 and diameter of eye 3.22 into snout.

External:—Body with apparently deep-sea form amongst this group by having soft touch and spinations, and also in coloration. Disc broad, its width much longer than length of disc. Anterior oblique margin of disc undulated, the anterior one-third convex, but the posterior rest concave. Snout very short, thickened, bluntly pointed and with somewhat indefinite small notch on both sides. Interorbital space very broad and flat, 1.59 times the diameter of eye. Eye relatively small, a trifle less than oblique length of spiracle, which is broadly opened, directing latero-anteriorly. Tail very long and slender, rod-like in shape anteriorly, but little flattened posteriorly, the length 1.09, and precaudal 1.42 into disc width. Dorsals very large, terminated together, and scarcely succeeding each other, interspace between them 29.0 into snout. Caudal fin distinct, projecting posteriorly beyond the tip of caudal axis in small extent. Ventral fin moderately notched, reaching near the anterior one-fourth of tail. Clasper very large, bar-like, globular at the tip, extending posteriorly half the way between cloaca and posterior end of base of the 2nd dorsal fin. Dermal folds on sides of tail obviously developed, broadened posteriorly, arising at the short distance rearward from the posterior end of clasper (Fig. 3 A).

Internal:—Rostral cartilage very short more or less stout, forming

* The specific name is dedicated to Dr. K. MATSUBARA to whom the author is much indebted for many favours.

** Of these, one specimen was gathered by Dr. K. MATSUBARA at Akkesi market, Hokkaido, in 1938.

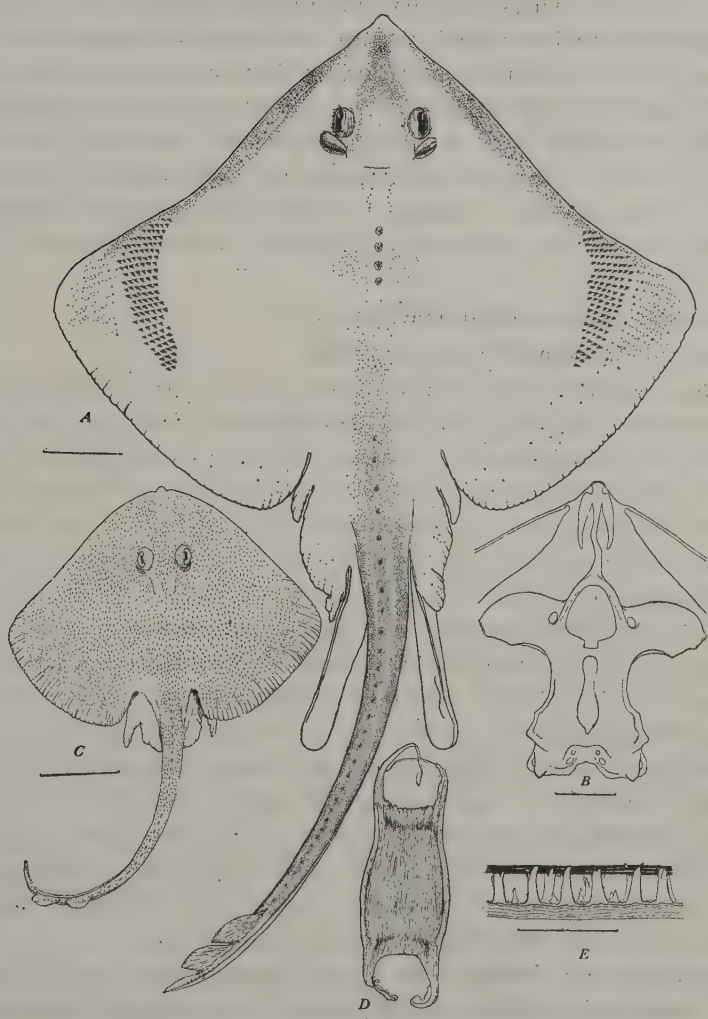


Fig. 3. *Breviraja matsubarae*, sp. nov. A, holotype; B, cranium and rostral cartilage; C, young female, total length 202mm; D, egg-capsule; E, semidiagrammatic illustration in the cross section of the capsule. A-D, dorsal views. These figures especially showing the difference in arrangements of the spines and prickles and also in the form of snout between A and C, and, large rostral wings in B, the arrangements of the spinules and fibroid hairs covered the surface of the capsule in E. Magnification of all the fig's are denoted by each scale graduating 1 cm, but 4 cm and 1mm scaled in A, E respectively.

tape-like bar; the wings very long and hanging posteriorly, its posterior tips extend beyond the half way to the origin of rostral axis. The maximum width of cranium much longer than that of the length inasmuch as the large nasal capsule being widely separated each other with straight line in their anterior margins. Anterior fontanelle very large, shaping just like the blade of spoon, and with small projection in posterior base. Posterior fontanelle elongated, narrowed anteriorly, and pointed rearward. Foramen for superficial ophthalmicus nerve large (Fig. 3 B).

Vertebral counts; 34 to 36+70 to 74.

Turns of intestinal valve; 11 to 12.

Spination:—Body with almost smooth surface on dorsal border of disc, excepting marginal and mid-belt portions. Skin over eye naked. A narrow but denser band of prickles covering anterior margin of disc, being to disperse posteriorly into wide band of scarcely visible prickles. The mid-belt of prickles in dorsal border of disc is interrupted with two narrow smooth portions, the first one covering between from the posterior margin of interorbital space and the 1st nuchal spine, the second starting in the posterior end of the spine, and running to a short distance rearward. Four large nuchal spines broadly developed, but nothing on shoulder. Tail thickly prickled accompanying a row of 30 large spines, reducing gradually in size toward both extremities. The prickles in lower lateral side of tail denser and larger, forming a clear band anteriorly, jointed to the mid-belt of disc between the ventrals. Ventral fin almost smooth, possessing a few prickles on posterior lobes; two dorsals and caudal sparsely prickled. Alar spines apparently developed, set in 23 rows transversely, 7 spines in a row for the broadest row. Lower surface of disc and tail entirely smooth (Fig. 3 A).

Coloration:—In formalin the dorsal surface heavy darkish purple, darker along mid-belt from nuchal to tail, but somewhat paler in the inner margin of eye-ball and posterior margin of spiracle. Lower surface a trifle fainter than dorsal, especially the anterior part of head; jaws almost colorless, but lower jaw with a dark blotch. The margin of cloaca and the posterior part of anterior lobe of ventral colorless; extremity of clasper and membranous folds on sides of tail being paler (Pl. 1 A).

Supplementally notes with paratypes: Proportional length of disc

against large dimensional parts of the body, such as total length, disc width and head length being varied individually in some extents within both sexes, however, these characters show rather less variations than as in other species throughout the life of the fish. But, proportional lengths of caudal fin and diameter of eye showing considerable variations with growth of the fish as indicated in Fig. 4. Of these, the

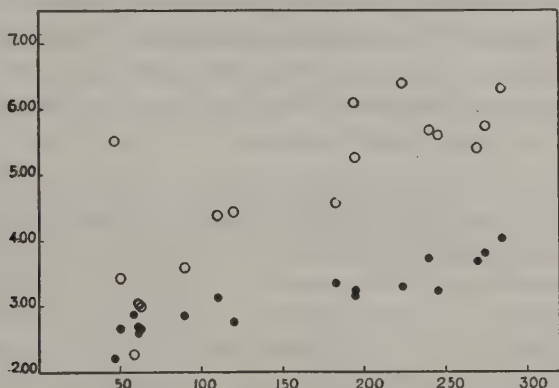


Fig. 4. Ratios of caudal-fin-length against head (○), and eye-diameter against snout (●) in relation to head as standard length in *Breviraja matsubarai*. Abcissa, head-length in mm; ordinate, ratios.

proportionate measurements of diameter of eye undergo remarkable change with the growth of the fish, *viz.*, interorbital space of adult about 1.0 to 1.5 times as long as the diameter of eye, but 0.7 to 0.8 times in very young stage. Similar phenomena in the proportional length of eye-diameter against snout, and that of caudal fin against head were noticed to exist.

A row of caudal spines apparently developing from the juvenile stage, ranging from 21 to 37, mostly 27 to 32 in number, and some individuals holding 1 spine between two dorsals. Furthermore, some specimens having the large spines, which never extend to the insertion of 1st dorsal being gently reduced in their size. In other one holding a row of the spines running continuously from the nuchal to caudal series, but mostly, 2-4 nuchal spines (range, 0-4) set in a row which isolated from the caudal series.

It is interesting to note the finding of many prickles on the dorsal surface in young stage, but they disappearing or the surface is almost

smooth in the adult as already mentioned in the holotype (*vide*, Fig. 3 A, C) and furthermore, such phenomenon of difference in the spination with growth of the fish is also notified to exist in the case of *B. diplotaenia*, which will be recorded later on.

Coloration in young stage somewhat differing from that of the adult by having heavy plum colour in dorsal surface and also marginal portion of under surface, and having the rest of colorless excepting the several faint blotches in the regions of nasal pores and gill slits (Pl. 1 C).

The proportional measurements of the bodily parts of the present species, which seem important to the clear identification from the related species are shown in Table 2.

Table 2. Proportional measurements in *Breviraja matsubarae* including both holotype and paratypes. Items in parenthesis for number of specimens.

Items	Holotype	Paratypes	
		Male (8)	Female (10)
In total length:			
Disc length	2.15	2.01—2.25	2.04—2.20
Disc width	1.64	1.58—1.82	1.54—1.77
Tail length	1.79	1.66—1.86	1.61—1.88
In disc length:			
Precaudal length	1.09	1.04—1.20	1.04—1.20
Mouth to cloaca	1.35	1.35—1.56	1.32—1.70
Head length	2.01	1.84—1.95	1.81—1.98
In head length:			
Snout length	2.83	2.26—2.60	2.08—2.55
1st dorsal length	3.84	4.22—5.00	3.88—4.70
2nd dorsal length	4.03	4.40—5.22	4.14—4.95
In snout length:			
Interorbital space	2.02	2.36—3.14	2.35—3.43

Egg-capsule moderate size, belonging *Isotrachys*-subtype. Namely, general feature of the own capsule just likes as that of *B. isotrachys* or the related species giving velvety texture with longer prickles on the entire surface (*cf.* ISHIYAMA, 1950, p. 32-33) but adhering the strong fibroid hair, by which the entire surface of the capsule is covered (Fig. 3 E). Length 105mm, width 55mm, anterior and posterior horns ca. 95, 60mm respectively.

It should be mentioned that, such peculiar surface of the capsule in this species as mentioned above must be the modification of *Iso-trachys*-type, so as being adapted to the niche in the deep-sea. It is believed, therefore, that the egg-capsule with such features as is the case with this species is thought to be specialized than those having the prickled surface, such as *B. isotrachys* and *B. diplotaenia*, etc.

Habitat :—This species are captured by motor-trawlers or the log-lines in the deeps from off Hokkaido and northern Japan proper along the Pacific (see Table 1.), the depth of the capture is greater than those of any other species of our skates. It attains at maturity at a total length of about 1200 mm. The spawning presumably be taken place mainly from the winter to spring.

Remarks: This species somewhat resembles North American deep-sea skate, *Raja abyssicola* GILBERT and THOBURN, 1896, but differs apparently from this related species by having any long close-set slender bristle-like spines on upper and lower surfaces in no case, and moreover very shorter snout instead of being longer in the latter.

Our specimens thus far examined are closely related to *Raja trachura* GILBERT, a North Pacific deep-sea form, but may be sharply defined from the latter in having 1) longer disc (the length 1.15 times into disc width in the latter), 2) longer tail (tail is longer than disc by a length equal to snout length in the latter), and 3) entire dorsel surface is mostly smooth in adult instead of being prickly in the latter as compared with the description of the similar sized specimen.

Breviraja diplotaenia *) , sp. nov.

Pl. 2, Text-fig. 5

Raja diplotaenia ISHIYAMA, 1950, p. 30, fig. 1, 2 (egg-capsule), Muroran.

Holotype.—No. 10886 (850mm, ♂, Pl. 2 A, Fig. 5 A), off Erimo Peninsula, Hokkaido, Oct. 18, 1948

Paratypes.—31 specimens ** (407-850 mm, Pl. 2), off Kushiro to Chōsi, Oct., 1948 and May to June, 1951; deep-seas.

Description: Disc length 2.03, width 1.46 and tail 1.80 into total length. Head 1.99, snout 4.19 and precaudal length 1.19 into disc length, which is 1.66 into disc width. Snout 2.10, length of 1st, 2nd and caudal fins 3.50, 3.62 and 5.25 into head respectively. Interorbital space 3.23, diameter of eye 2.85 into snout.

External:—Body very flat, generally thinner than in related forms. Disc very broad, much wider either than length of tail or than length

* From the Greek, *diplo*, double, and *taen*, band or ribbon, ventral fin divide into double ribbons.

** Of these, 2 specimens were collected by Dr. K. MATSUBARA from the same regions.

of disc, 1.23 times as great as the former; anterior oblique margin of disc nearly straight, being slightly convex in the anterior lateral margins opposited orbits. Snout rather long, flat and acute, with somewhat obvious notches near the distal portion. Interorbital space flat, but slightly convex along the median line, broader than eye-diameter; spiracle large, almost as long as eye in diameter, directing foreward and slightly outward. Tail slender rod-like in shape, precaudal 1.66 into disc width, and procaudal 1.73 into head. Two dorsals conspicuously large, terminated together, and similar in shape, but the 1st slightly larger than the 2nd in their oblique length; caudal fin small, being reduced into a low fold, projecting posteriorly beyond the terminal of the vertebral axis. Ventral fin peculiar, strongly notched, dividing two clear lobes,^{*} and the anterior lobe falciformed, directing backward and foreward; length of ventral incision 1.35 into snout. Clasper large, shaping the rod-like, 2.40 and 2.70 times as long as the length of disc and tail respectively. Dermal folds along sides of the tail starting near the posterior one-third of the tail, becoming very broad posteriorly, the broadest part opposited the posterior end of base of the 2nd dorsal fin (Fig. 5 A).

Internal: - Rostral cartilage long, tapering in shape; the wing rather short and narrow, about one-third as long as the rostral cartilage. The nasal capsule very large, distending anteriorly. Anterior fontanelle very large, characteristic in form, being boat-shape with truncated base, but posterior one slender, the anterior half is constricted and the rear end is pointed. Foramen for superficial ophthalmicus nerve very large, and ovoid in general form (Fig. 5 B).

Vertebral counts, 33 to 35 + 70 to 73.

Turns of intestinal valve, 10 to 11.

Spination: - Body almost smooth in the main region of dorsal surface of disc, with exceptions of marginal regions and also mid-belt of disc being sparsely prickled from the anterior portin of eyes rearward to interorbital space, then running backward and connect with the band of denser prickles of tail. Skin over eye and ventral fins without prickles. Nuchal and scapular spines absent. Tail thorny with numerous prickles, forming clear characteristic thorny band together with that of the mid-belt of disc. A median row of 25 large spines with broad base running the median line of dorsal boader of tail being originated at the

* This characteristic feature was taken into the specific name.

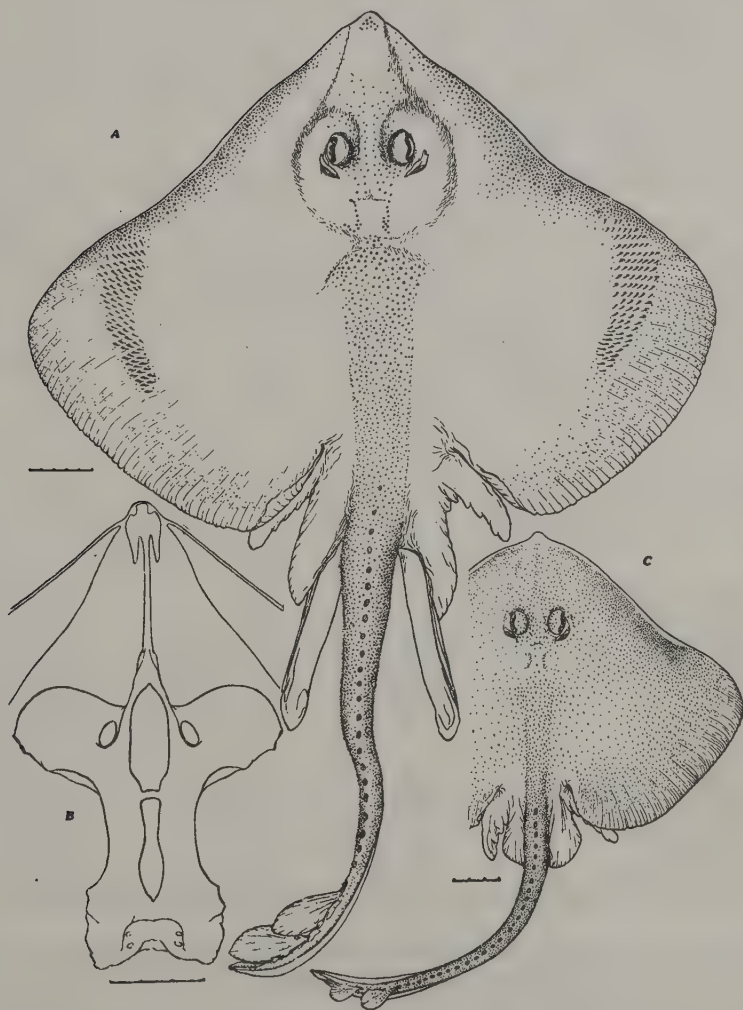


Fig. 5. *Breviraja diplotaenia*, sp. nov. A, holotype; B, cranium and rostral cartilage, and C, young male, total length 409 mm. Especially showing the deep notch of ventral fin and the dermal fold along the side of tail in A and C, and the difference in spinations on dorsal surface in C against A. Magnifications are same as in Fig. 3.

opposite with the cloaca, but without spine between two, which are sparsely prickled together with caudal fin. Alar spines broadly developed in 22 (in left side), 23 (in right) rows, 8 spines in a row for the widest series. Under surface smooth with an exception of spination in the very small area at the tip of snout.

Coloration:—In life prior to preservation, uniformly faint rosy, but dark chocolate in formalin, on dorsal surface; inner margin of eye fainter; clasper and posterior lobe of ventral fin darker, but colorless in anterior lobe. Under surface colorless, excepting latero-posterior margin of disc and posterior lobe of ventral fin, which are faint purple; cloaca edged with a band of dark brown, and chocolate color the tail.

Supplementally notes with paratypes: Proportionate measurements of bodily parts notified by the following Table:

Table 3. Proportional measurements in *Breviraja diplotaenia* including both holotype and paratypes. Items in parenthesis for number of specimens.

Items	Holotype	Paratypes	
		Male (15)	Female (16)
In total length:			
Disc length	2.03	2.01—2.16	1.95—2.14
Disc width	1.46	1.41—1.66	1.42—1.55
Tail length	1.80	1.70—1.81	1.73—1.84
In disc length:			
Head length	1.99	1.85—1.98	1.86—1.98
Snout length	4.19	3.67—4.50	3.60—3.97
Precaudal length	1.19	1.10—1.22	1.07—1.26
In head length:			
1st dorsal length	3.50	3.52—4.00	3.65—4.33
2nd dorsal length	3.62	2.81—4.72	3.76—4.52
Caudal length	5.25	4.25—7.85	4.70—10.09
In snout length:			
Eye-diameter	3.85	3.04—3.91	3.18—4.24
Interorbital space	3.23	2.86—4.19	2.86—3.94
Length of ventral incision	1.35	1.22—1.55	1.36—1.84

As in the general cases within the rajids, proportional length of tail larger in young than in adults in some degree, and precaudal assigned more stable character in proportion than procaudal one. Distance between dorsals varying in great extent, but they usually closed together. Proportional length of snout varies in accordance with sex and age in some measure, *viz.*, larger in females than in males, and also larger in young than in adults. Interorbital space apparently larger than diameter of eye in adult, but larger the latter in young stage inverting the relations in their proportions when the fish being attained about 500 to

600 mm in total length.

The gradual disappearance in the spination with growth of the fish in dorsal surface was also notified in this species as aforerecorded in *B. matsubarai*, (Fig. 5 A, C).

Egg-capsule, *Isotrachys*-type (ISHIYAMA, 1950).

Habitat: - Deep-seas, from off Choshi to Kushiro (Table 1); attains at maturity at a total length of about 900 mm. The spawning may be last from the late of autumn to the winter.

Remarks: The present species resembles in general *Cruriraja poeyi* BIGELOW and SCHROEDER 1948, but make it separable at a glance from the latter by having deeply notched ventral fin, instead of complete separation of anterior lobe from the posterior one in the latter.

Further, the species is closely related to *B. abasiriensis*, which will be recorded in this paper as new to science, but it will be distinguished from the latter and the allied members included in the genus *Breviraja* by having much deeply notched ventral fin. And, it may be also notified that present species was captured in the northern Pacific of Honsyu; on the contrally, *B. abasiriensis* appears to be restricted to the Okhotsk Sea.

Of this species the present author merely given the characteristics of the egg-capsule provisionally under the name of *Raja diplotaenia* (1951: p. 30). It goes without saying that species should be included to genus *Breviraja* at least by having the diagnostic feature of the rostral cartilage of the genus.

Breviraja abasiriensis *) , sp. nov.

Pl. 3, Text-fig. 6

Holotype.—No. 16000 (715 mm, ♂; Pl. 3 A, Fig. 6 A), off Abasiri, Okhotsk Sea; June 5, 1951.

Paratypes.—9 specimens (622-714 mm, Pl. 3 B), offing from Abasiri to Monbetsu, Oct., 1948 and May to June, 1951; rather deep-seas.

Description: Disc very flat and much limp in fresh, the length 1.92, the width 1.43, tail 1.83 into total length. Head 1.85, snout 4.18, precaudal 1.16 and distance between tip of upper jaw and cloaca 1.55 into disc length. Snout 2.26, 1st, 2nd dorsal and caudal fins, 5.03, 5.15

* Abasiri, one of the city in northern Hokkaido that lies on the coast of the Okhotsk Sea, where the mostly specimens of this species were gathered.

and 10.05 into head respectively. Interorbital space 3.71 and eye-diameter 3.56 into snout.

External: — Body with broad disc and very soft snout; disc much broader than the long, the width 1.47 times as great as the latter. Anterior oblique margin of disc strongly undulated, convex in opposite margin of the eye, and deeply concave in posterior two-third portion. Snout acut, bluntly pointed with a pair indefinite small notchs near the tip. Interorbital space rather narrow, weakly concave, nearly as broad as the eye-diameter of that of spiracle. Tail rather long and flat dorso-ventrally in cross section, 1.23 times into disc width. Ventral fin moderate, obviously notched the anterior lobe broad. Two dorsals somewhat large, terminated together, 2nd dorsal a little smaller than the 1st, being inserted small interspace between them. Caudal fin rudimentally, overlapped by the lobe of 2nd dorsal, precaudal length 2.87 times into head. Clasper rather long and stiff in touch, extending half to tip of tail exclusive of caudal fin. Lateral fold of tail broader posteriorly, the origin opposite to tip of clasper.

Internal:—Rostral cartilage rather slender, but shorter than length of the cranium; the wing very short, measuring about one-third the length of the rostral cartilage. Nasal capsules slightly domed anteriorly on both sides; anterior fontanelle large, elongating into a spoon-like in shape and the posterior one-fourth is moderately constricted; posterior fontanelle rather broad, gradually becoming narrower toward the middle, and pointed at the rear end. Foramen for superficial ophthalmicus nerve very small, and roundish in shape.

Vertebral counts; 33 to 34 + 66 to 68.

Turns of intestinal valve; 8.

Spination: — Disc weak and sparsely prickled with the exception of marginal, mid-belt and orbital regions, where the disc rather strongly armed. Prickles in orbital region largest in those of the supraorbital rim. Marginal region of the disc armed densely with prickles, the armature beginning from opposite of eye and extends rearward to near the base of the ventral. Prickles in the mid-belt of disc extend rearward from the portion opposite to the anterior vertebral-plate and jointed posteriorly with caudal band of prickles. A patch of smooth area is found to exist before the beginning of the armature of mid-belt and immediately behind the spiracle. Posterior portion of disc margined with smooth space. Skin

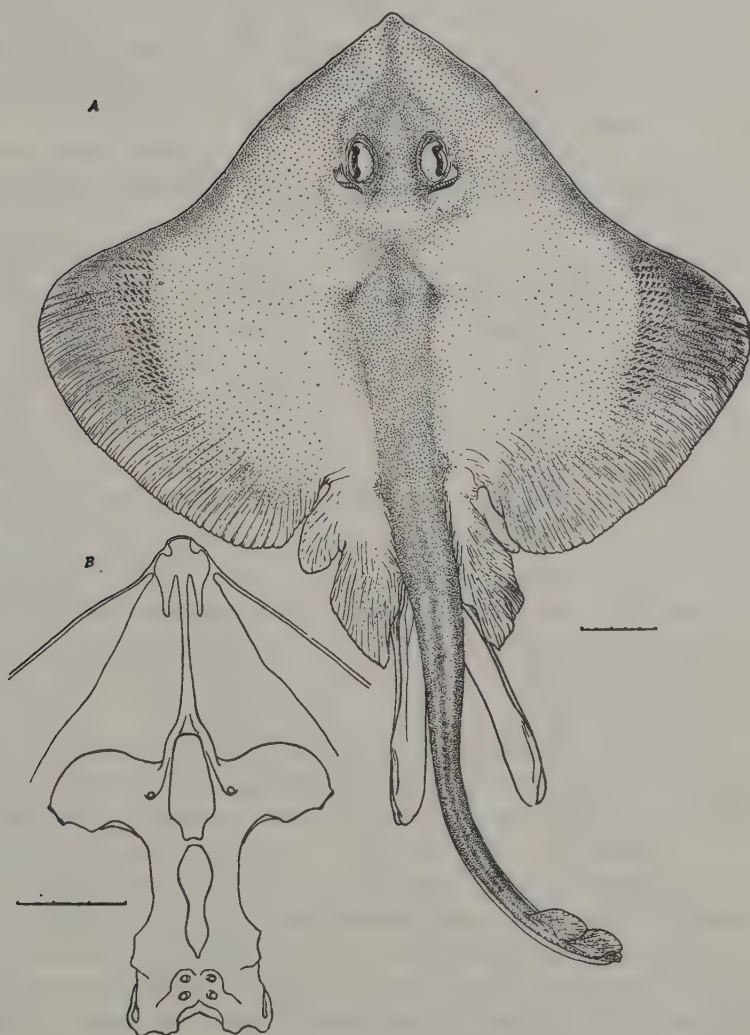


Fig. 6. *Breviraja abasiriensis*, sp. nov. A, holotype; B, cranium and rostral cartilage. Magnification are denoted by the same method as in Fig. 3.

covering eye poorly armed with very small prickles. Anterior lobe of ventral unarmed, but the central part of the lobe weakly prickled. Dorsal surface of tail entirely prickled, being slightly larger along lower lateral side. Without any large spines at nuchal or shoulder regions, but somewhat enlarged ones developed at places in a single series on tail, arising near the anterior one-third of the tail and ending near the insertion of the 1st dorsal. Under surface smooth, excepting the extremity of snout.

Coloration: - Color patterns on dorsal surface are characteristic, giving a clear diagnostic identification of the species (See Pl. 3), although usually more or less variable in their distribution. Greyish brown in base coloration bearing the many dark brown patterns with irregular shape on dorsal border of disc; the base color on mid-belt, posterior lobe of ventral, dorsal surface of clasper and tail are darker. Similar, but indefinite several dark bands crossing the dorsal surface of tail. Supra-orbital rim fainter, and anterior lobe of ventral markedly edged with white. Under surface colorless with the exceptions of dark greyish margin of cloaca, plumbeous posterior lobe of ventral, and the greyish brown tail.

Supplementary notes with paratypes: The proportionate lengths of tail and snout show the short differences by sexes. Namely, tail proportionally longer in male than in female, while the snout shorter in male than in female. Therefore, the ratios which introduced from these two parts against other dimensions of the bodily parts are caused to give rise more or less differences between two sexes. Accordingly, proportional measurements such as disc length and disc width against tail, snout against head, and interorbital space and diameter of eye against snout, all showed considerable sexual differences. The bodily parts other than mentioned above denoted rather proportionally stable between the sexes. 1st dorsal more or less larger than the 2nd, these are separated by a short space, but never jointed together with their bases, the space 24.3 to 93.0 times into head length; proportional length of caudal fin indicating rather stable values covering from 2.24 to 2.82 times into head length in adult specimens.

The modes of both arrangement and distribution of prickles on dorsal surface of the disc are similar as those of the holotype, although small individual variation being noticed to exist. Large spines developing along the median line of dorsal surface of tail, varying from 8 to

15 in number, being interrupted here and there, and reducing in size for either ends of the series.

Dimensions of the bodily parts which are thought to be useful for the identification of the species were tabulated as:

Table 4. Proportional measurements in *Breviraja abasiriensis* including both holotype and paratypes. Items in parenthesis for number of specimens.

Items	Holotype	Paratypes	
		Male (4)	Female (5)
In total length:			
Disc length	1.92	1.94—2.00	1.84—2.00
Disc width	1.43	1.41—1.57	1.46—1.56
Tail length	1.83	1.76—1.90	1.83—1.94
In disc length:			
Head length	1.85	1.79—1.90	1.91—1.97
Snout length	4.18	4.10—4.15	3.69—4.05
Procaudal length	1.16	1.12—1.20	1.14—1.36
In head length:			
1st dorsal length	5.03	4.25—4.83	4.70—5.60
2nd dorsal length	5.15	4.65—5.58	5.08—6.32
Precaudal length	2.87	2.24—2.78	2.30—2.80
Caudal length	10.05	8.58—13.30	7.48—9.00
In snout length:			
Interorbital space	3.71	3.36—3.50	3.68—4.23
Eye-diameter	3.56	3.40—3.62	3.72—3.88

Unfortunately, the young specimens and also egg-capsules of the present species were not available, but the speculation on the various characters of the species offers to remind us the egg-capsule should belong to *Isotrachys*-type.

Habitat: — This species may be northern form that being restricted to the Okhotsk Sea and the neighbouring^{*)}, but very rare in the northern coast of Hokkaido.

Remarks: The present species resembles *Raja trachura* GILBERT, known from southern California, in general physiognomy, but it sharply differs from it in having 1) longer disc (1.22 to 1.40 in total length instead of being 1.50 in the latter), 2) weakly prickled disc instead of being sparsely and evenly covered with small, sharp prickles with stellate base in the latter, 3) prickled supraorbital rim (smooth, but a single small tubercular spine developing on nuchal and shoulder regions in the latter) and peculiar coloration, thus: upper surface of disc is

* Mr. T. DOMON, who had been passed as a fisherman in Sakkalin, said to the author as "this species is often trawled in the coast of Sakkalin, whereby it has been called as *Ijin kasube*", the foreign skate.

greyish brown furnished with many dark brown patterns with irregular shape (plum colour without any patterns in the latter); under surface colorless (brown in the latter).

Rhinoraja ^{*)}, gen. nov.

External: — Body soft and flexible. Snout short and blunt. Tail very long and stout, longer than length of disc, bearing a row of large spines along the median line of the dorsal surface which armed with minute prickles. Nuchal, orbital and pectoral regions evenly prickled at least in the adult, but entire dorsal surface is thickly prickled in the young stage.

Internal: — Rostral cartilage with a segment, and other characters are essentially the same as in the genus *Breviraja* described in the foregoing chapter.

Vertebral counts; 30 to 37 + 74 to 82.

Turns of intestinal valve; 8 to 10.

Type species: *Raja kujiensis* TANAKA

In 1916 TANAKA erected a new species, *Raja kujiensis* (in Japanese), from Kuji, Ibaragi Prefecture. Besides this, in 1927 the same author erroneously described a new rajid, *Raja tobae*, that have been preoccupied by his another species from Toba, Mie Prefecture (1916) (in Japanese), and later, he gave a new name, *Raja karagea* for the species described in 1927.

Since my careful study on the figures and descriptions recorded by TANAKA in 1916 and 1927 mentioned above being compared to my specimens involving various size of the fish, I inclined to think that *R. kujiensis* and *R. karagea* are synonymous, in that case the former has priority cover *karagea*. To quate example, the spination on dorsal surface which scarcely serve for separating these two species of TANAKA should goes to sexual dimorphisms of the species as far as my investigation is concerned.

As already mentioned in the foregoing chapter, the genus *Breviraja* BIGELOW and SCHROEDER, which was emended by the author, is found quite identical with the type of the genus, which has a segment in the rostral cartilage, and it should be taken as a good generic character.

Hence, the creation of the new genus *Rhinoraja* is based on

* From the grec *rhino*, nose, *Rhinoraja*, *Raja* with peculiar projection in the rostrum.

Raja kujiensis of TANAKA 1916.

It may be thought that the new genus *Rhinoraja* very closely resembles *Breviraja*, besides, there is a monophyletic relationships through *Breviraja* to *Rhinoraja*.

Two species are referable to the new genus, of which one put as new to science as recorded later on.

In the landing by means of motor-trawlers, operating at the deeps along the Pacific coast off Chōsi to Kushiro, especially off Hachinohe and Muroran, these two species are rather common.

Rhinoraja longicauda, sp. nov.

Pl. 4, Text-fig. 7

Holotype.—No. 16737 (665 mm, ♂, Pl. 4, A, Fig. 7), offing from Hachinohe to Erimo Penninsula, May 23, 1951.

Paratypes.—25 specimens*) (305–688 mm, Pl. 4, B, C), offing from Chōsi to Kushiro, Oct., 1948 to June, 1951; deep-seas.

Description: Disc length 2.20, width 1.62 and tail 1.70 into total length. Head 1.97, snout 4.87, precaudal 0.93 into disc length, which is 1.27 into disc width. Snout 2.47, preoral length measured from upper margin of the teeth band in upper jaw to the tip of snout 2.38 and length of 1st and 2nd dorsal fins 3.64 and 3.82 into head respectively. Interorbital space 3.10 and diameter of eye 2.70 into snout.

External: — Body with robust appearance; disc broad, strongly undulated in the anterior oblique margins as in other species; the width almost equal to the length of tail, which is much longer than length of disc. Snout very short and rather pointed; interorbital space moderate in breadth and shallowly concave; eye large, the diameter contains 1.15 times in interorbital space; spiracle broadly opened, directing outward and foreword; the oblique length almost as great as the interorbital width. Tail very long, stout and somewhat flattened dorso-ventrally, the length 1.05 precaudal 1.27 into disc width respectively. Dorsals rather small, terminated in close together at the posterior portion of tail; interspace between them 51.0 into head; caudal fin very small, 4.76 times in snout. Clasper very slender, the length 2.90 times into tail; dermal fold along sides of tail very broad posteriorly, arising near the midway between base of clasper and end of the tail, the maximum

breadth almost equal to longitudinal diameter of the pupil, setting up in opposition between origin of both 1st and 2nd dorsal fins. Ventral fin moderately notched and the anterior lobe somewhat falciformed, ventral incision 3.73 times into head.

Internal: - Rostral cartilage very feebly elongated, and having a segment at the posterior one-third of the cartilage; rostral appendix wide but short, hanging posteriorly, scarcely in contact with anterior extremity of pectoral radialis in two sides. Olfactory capsules expanding bilaterally with horizontal anterior margins. Anterior fontanelle large, rectangular in shape, becoming narrower anteriorly, but posterior one very long and narrowed in two portions, and the posterior end pointed. Foramen for superficial ophthalmicus nerve large and ovoid in general appearance.

Vertebral counts; 30 to 33 + 74 to 81.

Turns of intestinal valve; 8 to 9.

Coloration: - In fresh prior to preservation, purplish grey in base color with indefinite darkish brown patterns or spots on dorsal surface, but these markings disappear soon after the fish is put in formalin solution or as time goes on after landing, and base color change into greyish brown or purplish brown. A distinct triangular white crest as large as spiracle occurring in front margin of the eye-ball, directing forward. Under surface white, excepting posterior oblique margin of disc and ventral fin and tail, all of which are faint purplish brown; a narrow band of dusky color edged cloaca.

Spination: - Entire surface armed with rather large but spiny prickles setting on the stellate base, they are numerous along anterior margin of disc and interorbital region in connection with the mid-belt of spination, but some-what sparsely in the main portion of pectoral, behind of spiracle and over gill chamber; skin covering eye and two dorsals prickled, but very fewer or none on posterior lobe of ventral, and nothing on anterior one as well as on the ventral surface of disc. A very large spines setting as nuchal one, and the same of 22 in a row running along the median line of the tail arising at the opposite portion of cloaca; none of shoulder spine. Interspace between dorsals naked; 18 rows of the backler spines, 7 spines in broadest row, on pectorals. Tail densely prickled above and sides, the prickles becoming smaller and denser toward lower lateral portion.

Supplementary notes with paratypes: Dimensional characters of the bodily parts described with holotype are essentially the same as those in the paratypes, although the variations in some extent are noticed to exist in accordance within either ages or sexes of the fish. Proportional lengths of caudal fin and interspace between dorsals show so large variations that these characters could not be taken as the specific constants. Further, the dimensional relationships between eye-diameter and snout length in the youngs, denoting more or less smaller than in the adults, especially these phenomenon notified in the female. Degree of undulation in anterior oblique margin of disc scarcely be seen or merely rounded anteriorly in both female and young. Variation in number of nuchal spine is large, covering 1 to 4, but 3 in most cases. Caudal spines running in a series, numbering 18 to 28, but 21 to 23 in most cases. These large spines apparently being developed still in young stage, wherefore the character may serve for the identification from other related species.

Coloration on dorsal border of the disc is fundamentally the same as in the holotype, but the patterns indistinct in young. The white crest in front of eye having neither in female nor in the young.

Proportional measurements of bodily parts which enable us to identify the present species from other related ones are shown in Table 5.

Table 5. Proportional measurements in *Rhinoraja longicauda* including both holotype and paratypes. Items in parenthesis for number of specimens.

Items	Holotype	Paratypes	
		Male (10)	Female (15)
In total length:			
Disc length	2.20	2.18—2.30	2.23—2.32
Disc width	1.62	1.62—1.77	1.73—1.89
Tail length	1.70	1.66—1.76	1.61—1.77
In disc width:			
Precaudal length	0.96	0.90—0.97	0.88—0.95
In disc length:			
Head length	1.97	1.89—1.98	1.89—2.01
Mouth to cloaca	1.44	1.38—1.59	1.35—1.53
In head length:			
Snout length	2.47	2.33—2.56	2.21—2.52
Preoral length	2.38	2.10—2.44	1.95—2.33
1st dorsal length	3.64	3.53—4.60	2.02—4.96
2nd dorsal length	3.82	3.83—4.79	3.88—5.95
Caudal fin length	11.75	7.25—10.68	5.80—11.70
In snout length:			
Diameter of eye	2.70	2.18—2.90	1.93—2.90
Interorbital space	3.10	2.90—3.62	2.94—3.56
In eye-diameter: Spiracle	1.10	1.69—1.33	1.17—1.60

Egg-capsule rather small, possessing intermediate feature between

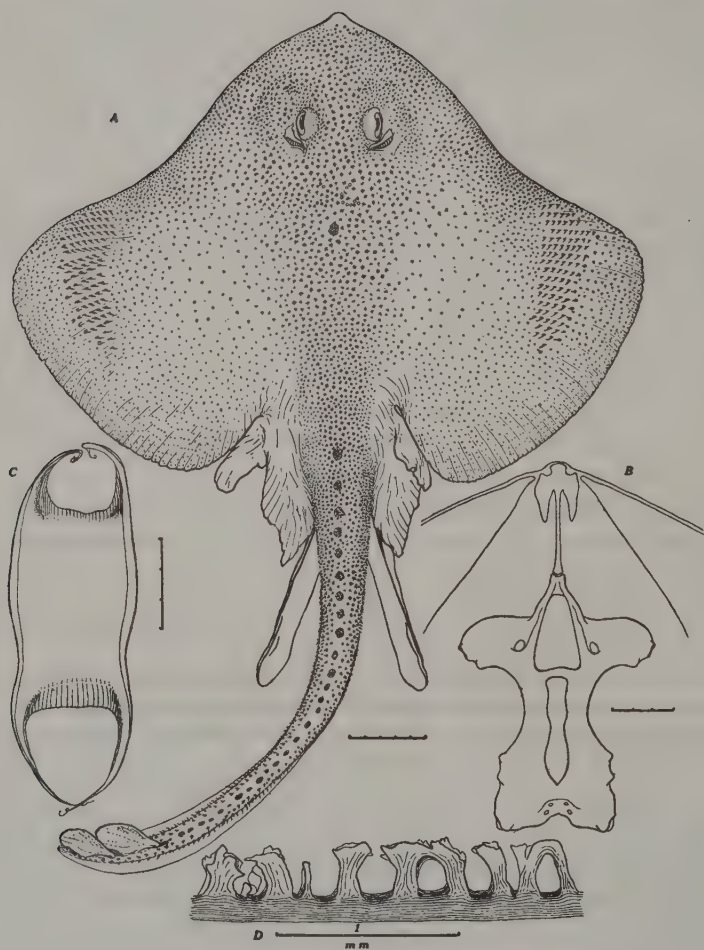


Fig. 7. *Rhinoraja longicauda*, sp. nov. A, holotype; B, cranium and rostral cartilage; C, egg-capsule; D, cross section of the capsule. Especially showing the distribution of both spines and prickles, and broad dermal folds along sides of tail in A, and also a segment of rostral cartilage in B. Magnifications in all these fig's other than D are indicated by each scale as the same in Fig. 3.

Isotrachys and *Parmiifera*-types, and therefore called herein *Isotrachys*-subtype for it, since the minute velvety prickles are seen between any stalked ridges which running lengthwise series, and the capsule bearing the long filamentous horn in each corner (Fig. 7 C, D). 3 pairs of the capsule were taken out from the females, measuring 587 to 620 mm in total length, which were captured from 350 to 450 fathoms deep. Measurement of the capsule are as follows; length 68 mm; width 46 mm; length of anterior and posterior horns, 43 and 32 mm respectively.

Habitat: - This species is probably distributed from Kúsiro to Chōsi, (*Vide*, Table 1), where the fish were observed as rather common fish in the landings, especially being abundant at Hachinohe market in the spring, captured from 300 to 450 fath's deep. The fish may attains at maturity at a total length of 700 mm, and spawning may be taken place in the spring, inasmuch as the capsules were very often taken out from the females in this season.

Remarks: In general physiognomy the present species resembles *Rhinoraja kujiensis*, especially in the young stage, but distinguishable from it in following points: 1) nuchal spines are much fewer, numbering 1 to 4, mostly 3, and they are not continuous posteriorly with those of caudal ones (the spines are larger in number and continuous with those of the caudal ones in the latter), 2) shoulder spines are entirely absent (a pair of shoulder spines are always present in the latter), 3) eye and spiracle in adult are smaller, and 4) precaudal longer than disc length (almost equal in the latter).

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PLATE I

PLATE 1

Breviraja matsubarae ISHIYAMA, sp. nov.

Fig. A. Ventral view of holotype.

// B. Adult female, measuring 1105 mm.

// C. Young male, measuring 259 mm.



PLATE 2

Breviraja diplotaenia ISHIYAMA, sp. nov.

Fig. A. Ventral view of holotype.

" B. Adult female measuring 797 mm.

" C. Young male measuring 452 mm.



PLATE III

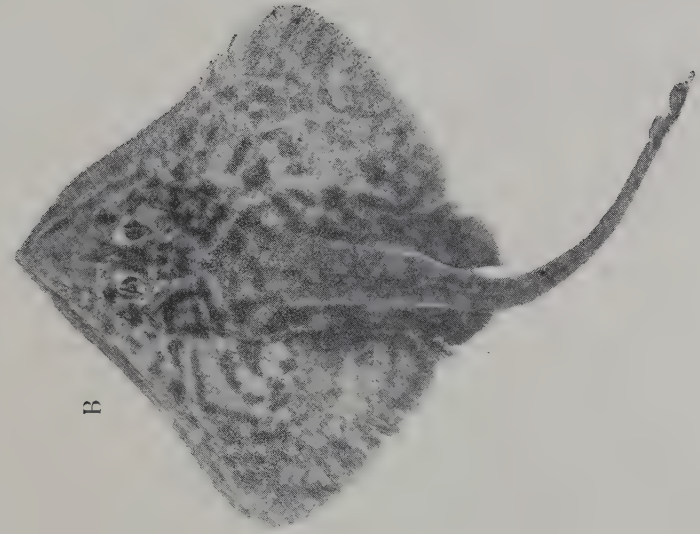
PLATE 3

Breviraja abasiriensis ISHIYAMA, sp. nov.

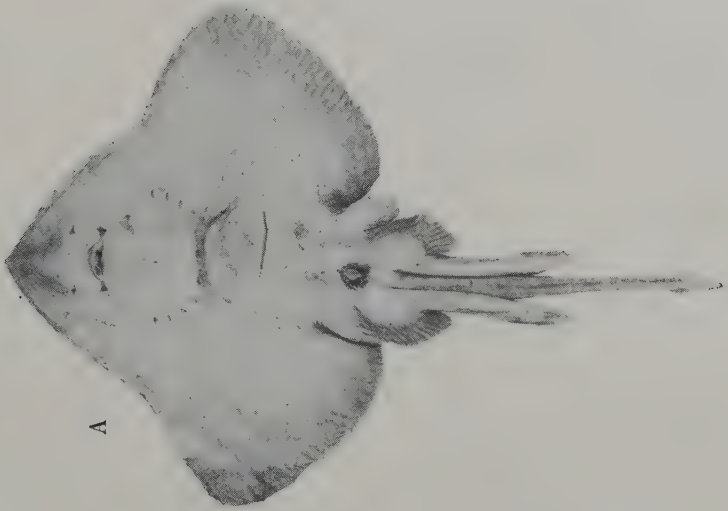
Fig. A. Ventral view of holotype.

" B. Adult female measuring 712 mm.

11



B



A

PLATE III

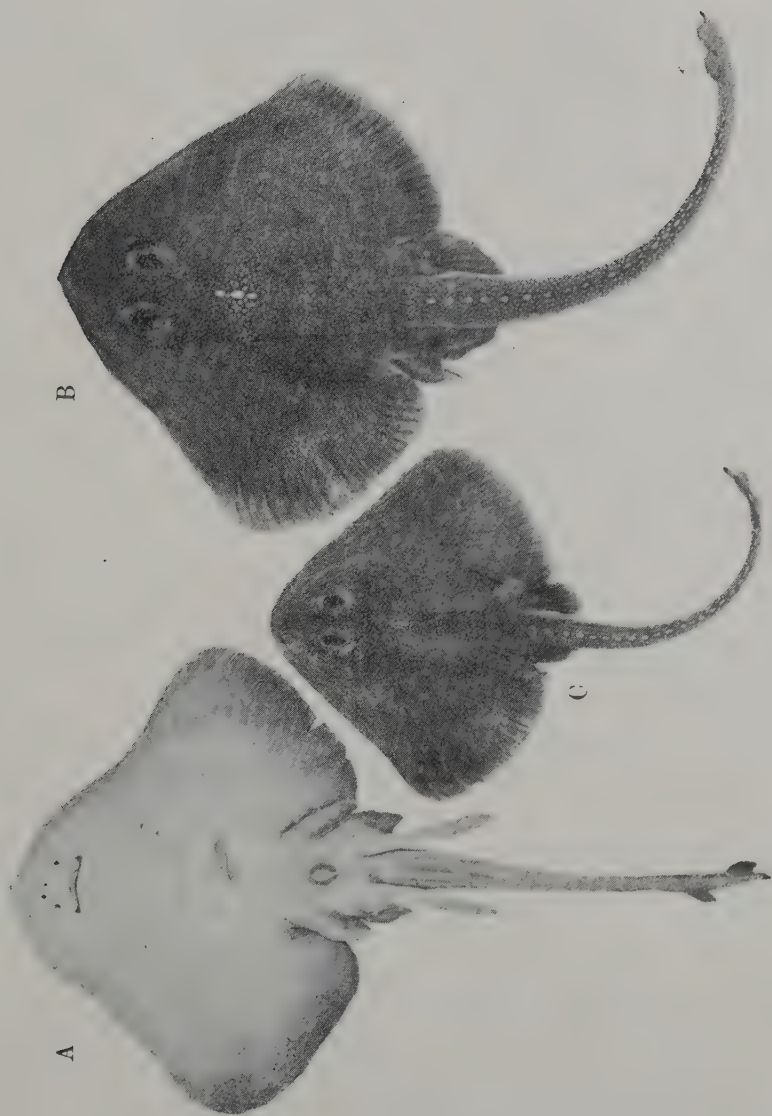
PLATE 4

Rhinoraja longicauda ISHIYAMA, sp. nov.

Fig. A. Ventral view of holotype

" B. Adult female measuring 602 mm.

" C. Young male measuring 490 mm.



ドジョウ卵巢の成熟過程に就いて

第1報 天然産ドジョウの卵巢の成熟過程^{*)}

久保田 善二郎

On maturing process of the ovary of a loach, *Misgurnus anguilli-caudatus* (CANTOR) 1.

Successive maturity of the ovary in the natural living loach.

Zenziro KUBOTA

- 1) The formation of oogonium begins after spawning and its number is most distinct during a period from the end of August to the beginning of September, but of course its formation is kept continually for a long time, even though its number decreases.
- 2) The monthly average of egg diameter (excepting the eggs of under 0.23 mm in diameter) was the following; Oct. 3, 0.264 mm, Dec. 16, 0.396 mm, Feb. 18, 0.496 mm, Mar. 20, 0.559 mm, Apr. 20, 0.669 mm, June 10, 0.706 mm.
- 3) The difference of maturing process of every egg in the same ovary depends upon the difference of time in the formation of oogonium.
- 4) The eggs of posterior-part and dorsal part of ovary mature in shorter period than those of anterior-part and abdominal part of ovary.
- 5) The eggs are spawned in June.
- 6) It takes about ten months from the formation of oogonium to spawning.
- 7) The growth of genital gland is not also stopped even in the time of hibernation.
- 8) It seems to me that the matured eggs left in the ovary after spawning are not kept up to the next spawning season but they are absorbed into the body of female fish.

藤田, 他三名 (1948)^{*)} はトノサマガエルの脳下垂体前葉ホルモン注射によるドジョウ卵巢の成熟過程について肉眼的観察を行い, 川村, 本永 (1950)⁵⁾ は同ホルモンをシマド

* 水産講習所研究業績番号第20号

1950年, 日本水産学会西日本支部大会に於いて講演

ジョウに注射して卵巢に起る變化を細胞學的に觀察した。然し天然に於けるドジョウ卵巢の成熟過程に就いての詳細な研究は未だない。川村 (1944)⁴⁾ によりホルモン使用によるドジョウの人工孵化の可能のことが實驗的に成功して以來種苗の大量生産が可能視されて來た今日この新しい増殖方法に對して一層の確實性を與える爲に本研究を行つた。本文を草するに當り懇篤な御指導を賜つた松井教授、研究に御助力下さつた吉岡俊夫氏に對し深く感謝の意を表する。

材料及び方法

1949年2月より、50年10月に亘り山口縣熊毛郡平生町附近の溝から雌ドジョウを採捕し10%ホルマリン溶液で固定後卵巢を摘出し、それを前部、中部、後部とに三等分し、更に中部を背部と腹部に二等分し、各部毎に少量の水を入れた小型シアラレー中にて各卵粒を分離し、それをスボイドにとりスライドガラスに滴下後、針で卵粒を一系列に無作意に列ベミクロメーターでその一端より卵細胞の最大徑を各部共 200~300 粒宛測定した。但し卵徑 0.23mm 以下の卵細胞は以上の様にして處理することが困難故9月のみ測定し他の月では除外した。卵徑 0.23mm 以上と、それ以下の微小な卵細胞とを生時並びに組織標本により比較すれば、前者は生時並びにフォルマリン固定後では乳白色並びに黄白色を帯び半透明或いは不透明であるが、後者は無色透明である。更に卵巢の切片標本によつて調べた結果、前者の卵黄粒はヘマトキシリンによく染まらないが後者は濃く染まる。又前者は卵膜に近接してその内側にヘマトキシリンに染まらない數個の円形又は楕円形をした脂肪油球が一系列、更に熟度の進んだものでは數列の配列をみるのに反し後者では脂肪油球は存在しない点で區別される。尙兩者共卵体の中央部に円形又は楕円形の胚胞があり膜によつて細胞質と境し、この周辺には大小の核仁が存在する。

供試魚數21尾、卵徑の測定に供した卵粒數は 14740粒である。

結 果

卵原細胞の形成は排卵後直ちに爲される様で7月中旬より8月上旬にかけて 0.76 mm 以上の卵徑を有する成熟未放出卵に混じて小數の10乃至 20 μ の卵細胞が見られる。而し9月3日に見られる如くその最も多く形成される時期は8月下旬より9月上旬である(第1圖)。

卵巢内には大小の卵細胞が混在しており産卵期に近づくに従つて小卵よりも大卵の割合が大になる。ドジョウ卵の色は大別して卵徑 0.23mm 以下では無色透明、0.23~0.38mm では乳白色、0.38~0.58mm では乳白色と黄白色と半々位、0.58~0.78mm では黄白色となり、0.78mm 以上では同じく黄白色であるが、これは熟卵と同じ卵徑を有するものである。卵徑 0.23mm 以下の卵細胞を除いたものを、以上示した卵徑に依り夫々 E_4 、 E_3 、 E_2 、 E_1 の各級に区分し、各級の混合割合を月別に示すと4つの曲線となる。即ち E_4 は10月3日では99.1%、 E_3 は12月16日では51.8%、 E_2 は4月20日では57.0%、 E_1 は6月10日に59.8%で夫々の曲線の最高値を示し E_4 より E_1 への移行の過程が見られる(第2圖)。

次に月別による卵徑の平均値(卵徑 0.23mm 以下を除く)を求めると第1表並びに第3圖の通りである。即ち10月3日 0.264mm、12月16日 0.396mm、2月18日 0.496mm、3月

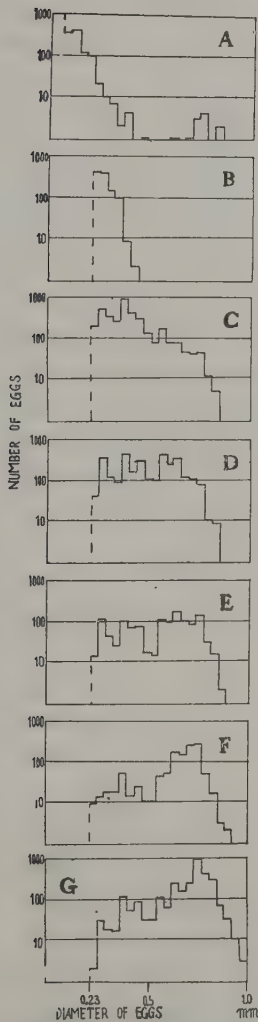


Fig. 1. Showing the relation between number and diameter of the egg (in mm); A, Sep. 11; B, Oct. 3; C, Dec. 16; D, Feb. 18; E, Mar. 20; F, Apr. 20; G, June 10.

Table 1. Seasonal variation of egg-diameter (in mm)

Date	Mean value	Standard deviation	Coefficient of variation
Oct. 3	0.264 ± 0.001	$\pm 0.037 \pm 0.001$	14.242 ± 0.229
Dec. 16	0.396 ± 0.001	$\pm 0.113 \pm 0.001$	28.594 ± 0.239
Feb. 18	0.496 ± 0.002	$\pm 0.146 \pm 0.001$	29.469 ± 0.279
Mar. 20	0.559 ± 0.003	$\pm 0.170 \pm 0.002$	30.417 ± 0.456
Apr. 20	0.669 ± 0.002	$\pm 0.120 \pm 0.002$	18.059 ± 0.256
June 10	0.706 ± 0.002	$\pm 0.135 \pm 0.001$	19.142 ± 0.170



Fig. 2. Monthly mixture percentage of large and small eggs in the ovary; $\triangle$, E_1 , 0.78mm-; $\square$, E_2 , 0.53-0.78mm; $\circ$, E_3 , 0.38-0.58mm; $\bullet$, E_4 , 0.23-0.38mm.

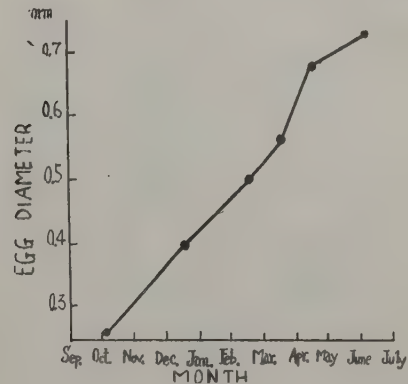


Fig. 3. Seasonal variation of egg-diameter (in mm).

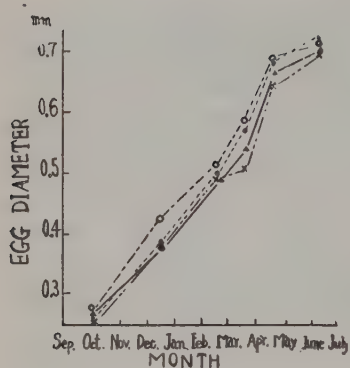


Fig. 4. Comparison of the diameter of eggs (in mm) following to the parts in the ovary; ● Dorsal part; ▲ anterior part; × Abdominal part; ○ Posterior part.

13.0%, 5月10日12.3%, 6月10日13.2%, 7月14日5.2%, 8月29日2.1%で、最小は9月11日、最大は6月10日であつた。これ等は卵径平均値の最小、最大の時期と夫々一致し、産卵盛期は6月であると考えられる(第5圖)。ドジョウは10月より3月の間冬眠し、体重は減少する⁷⁾が、卵巣重量並びに卵径は増大する。

考 察

卵原細胞の形成は第1圖及び第2圖のE₄の曲線よりして、その數量は減少するが、卵原細胞は長期に亘り形成されるものと思われる。従つて同一卵巣内に於ける卵の成熟度合の差異は、個々の卵並びに卵巣の部分による成熟の遲速にもよるが卵原細胞の形成される時期の差異によると考える方が妥當である。卵原細胞が形成されてより産卵迄に要する期間は、大多數の卵原細胞が8月下旬より9月上旬に生じ翌年の6月に産卵される故、約10ヶ月を要するものと思われる(第2圖)。

排卵後の卵巣内に於ける成熟未放出卵がどうなるかの問題は、第1圖より次の事が考察される。即ち9月では0.6mm以上の卵径を有する比較的大きい卵が認められるが10月で

20日0.559mm、4月20日0.669mm、6月10日0.706mmで1ヶ月平均0.056mmの卵径の増加をみる。

更に卵巣の各部分の成熟過程を比較する爲に卵巣を前部、背部、腹部並に後部に分けて卵径を測定した結果、後部、背部卵巣の卵は前部、腹部卵巣のそれよりも卵径が大きい。従つて成熟が早いと言える(第4圖)。このことは、藤田他三名(1948)⁸⁾がホルモン注射後に於けるドジョウ卵巣の成熟は、後部卵巣より背部、中部前部卵巣へと進み腹部の消化器を圍繞する部分が最も遅れる結果と一致する。

次に卵巣重量と産卵時期との関係をみる爲に月別に依る卵巣重量の体重に對する割合を求めると9月11日1.6%、10月3日1.9%、12月16日3.0%、2月18日5.2%、3月20日8.1%、4月20日

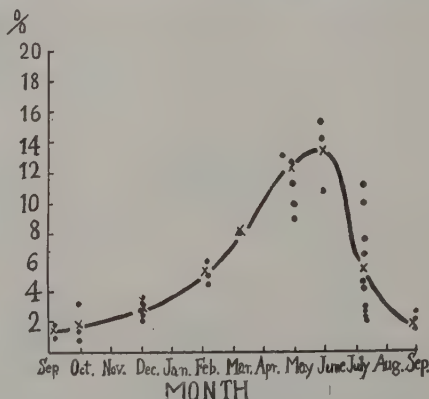


Fig. 5. Monthly percentage of the weight of ovary to the body weight.

は見られない。9月に於ける卵巣内は0.2mm以下の微小な卵細胞で充満され、その中に以上述べた大卵が卵巣の各部分に点在しており、大卵のみが体外に排除されるとは考えられない。故に成熟未放出卵は崩壊し、体内に吸収され消失するものと考えられる。

次に第5圖に於いて7月に、もし産卵を終っていないとするならば、卵巣重量の体重に對する割合は、6月と同じく10%以上、又産卵を終っているとするならば、9月と同じく大体に於いて4%以下の筈である。然るに4~10%の個体が認められる。これ等は産卵が、數回に行われること並びに成熟未放出卵が消失する過程を示すものと考えられる。

摘 要

- 1) 卵原細胞の最も多く形成される時期は、8月下旬より9月上旬である。然し數量は減少するが長期に亘り形成される。
- 2) 卵径0.23mm以上の卵径平均値は10月3日0.264mm、12月16日0.396mm、2月18日0.496mm、3月20日0.559mm、4月20日0.669mm、6月10日0.706mmであつた。
- 3) 同一卵巣内各卵の成熟度の差異は、卵原細胞の形成される時期の遅速による。
- 4) 卵巣の後部、背部の卵が、前部、腹部のそれよりも成熟が早い。
- 5) 卵原細胞が形成されてから排卵迄に大体10ヶ月を要する。
- 6) ドジョウの生殖腺は、冬眠期中に於いても發達の過程を示す。
- 7) 産卵後の卵巣内に於ける成熟未放出卵は、翌年産卵されない。

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ヒジキの生態学的研究 第1報

小湊に於るヒジキ及びウミトラノヲの群落に就て*

片 田 実

Ecological Studies on *Hijikia fusiforme* (HARV.) OKAM., (I).
On the Communities of *Hijikia fusiforme* (HARV.) OKAM. and *Sargassum Thunbergii* (MERT.) O. KUNTZE at Kominato, Chiba Prefecture.

Minoru KATADA

For the conservation of the popular food sea-alga in Japan, *Hijikia fusiforme* (HARV.) OKAM., I have made some ecological studies on its association.

- 1) Factors of habitat at the association of *H. fusiforme* and other members of alga which mixed in that association were investigated (Fig. 1,2).
- 2) In the mixed association, as expected, the quantity of production of *H. fusiforme* correlates with that of *Sargassum Thunbergii*. This correlation is shown by a strong curved line, which seems to show a keen competition for their both existence (Table 1,2, Fig. 3,4).
- 3) By having made clear the principle and process of this competition, the effective method of the removal of *S. Thunbergii* has been found for the purpose of propagating *H. fusiforme*.

緒 言 筆者は1939~40年千葉県内浦灣水産講習所** 小湊実験場地先岩礁の禁漁区でヒジキ *Hijikia fusiforme* (HARV.) OKAM. の群叢と生育の状態を研究して報告したが、²⁾ ³⁾ その後 1948年 夏以降同地に滞在して、更に研究を續けた結果相當の新知見を得た。茲にその一部を報告する次第である。

實驗に當り御指導、御援助を賜つた故中井信隆、故中村秀也兩恩師に深謝し、更に種々便宜を與えられた猪野峻助教授、有益な御助言を與えられた殖田三郎博士並に瀬川宗吉博士に厚く御禮申し上げる。

I. ヒジキ群叢の概説

A. ヒジキ群叢の外的環境 内浦灣は房總半島の東南に位置し、直接太平洋に開口しているため相當波浪が強く、特に調査地域は灣口に近い爲激浪を受ける日が多い。

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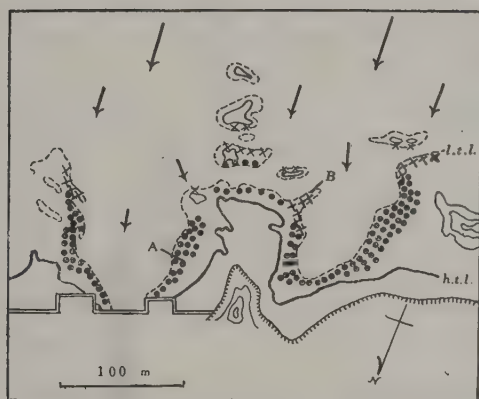


Fig. 1. A rough sketch which shows the correlation between the community of *H. fusiforme* and wave. ● closed community × Open vegetation ← Wave

此處の潮間帯海藻相観中ヒジキ群衆は最も顯著であるが、それを以てヒジキが特に波浪に適しているとはいふ難い。即ち仔細に觀察すれば波浪の稍々靜かに上下動する凹入部に最もよく繁茂しており、凸出部程群衆が減少している。とはいえ凸出部でも各個体の生長は決して悪くない。突端の荒浪の衝に當る所には普通見られないが稀に疎生していることがある (Fig. 1)。B 地地点附近は前の調査時には疎生していたが後には密生していた。このような波浪状況の中間に當る地域では群落の消長が激しいのであろうか。

生育帯の幅は波浪の状況によつて多少の變化はあるらしいが、繁茂地帯では平均水面を上部限界としてその下方約 60cm の範圍で、下部限界は潮望平均干潮位より約 30cm 上方となつてゐる。但し荒浪の衝に當る所に見出される場合は上限が僅かながら上昇しているようである。又生育帯の上下際では伸長は常に著しく不良である。

次にヒジキは岩礁の周縁に多く見られ、奥部に行く程減少する傾向がある。但し稍々奥部と雖も裂隙の沿縁には稍々疎ではあるが生長の良いものが常に見られ、特に裂溝の方向が波浪の方向と一致している場合に著しい。又浅い潮溜りの周縁附近にも相當繁茂し、その部の傾斜が緩かな程密になつてゐるが、潮溜りの内央部や深い潮溜りには見られない。

調査地域の岩盤の大部は軟い且小凹凸のある泥岩からなつてゐるが、これはヒジキの着生には好適のようである。そして硬く滑かな岩面が露出している所には着生不良である。なおコンクリート面には附着し難い。

附着面の傾斜度は着生の度合と顯著な關聯があり、水平もしくは緩傾斜が良く、傾斜が急な程着生不良であり、垂直な平滑面には普通着生を見ない。

B. ヒジキの生育と隣接群落 前記の通りヒジキの生育帯はその上下の限界が極めて明瞭であつて而もそれは潮位と密接な關係があり、高低潮と低々潮に挟まれる部位 (即ち 1 年を通じて 1 日 1 回干出する日が最も多い部位) にあたつてゐる。ヒジキの群衆に隣接している上位群落としては干出浸漬が日に 2 回宛繰り返されることの多い部位附近に平均水面の稍々上方を中心として特に狭い生育帯を作るイワヒゲ、イシゲ及びイロロ等の純粹又は混濁の群落が普通で、冬春季にはハバノリ、カヤモノリの顯著な群落と接觸する。そしてヒジキ群衆が良好に發達した地帯ではこれら上位群落の生育帯の幅は特に狭くなる傾向が認められる。下位群落としては大潮潮にあたつて時々干出することがある部位にビリヒバ等の小型有節サンゴモ類やソゾ類が顯著である他ツノマタ、オキツノリ等がある。更にその下位にイソモク、ナラサモ等のモクの類や、やや大型の有節サンゴモ類の群落を始め

として多くの種類が出現する。これらは本来漸深帯のものであるが、裂隙、潮溜り等に於てヒジキ群叢に接近している。

以上は大体瀬川の報じた南伊豆の海藻群落と類似している (Fig. 2)。

C. ヒジキ群叢の混生海藻 ヒジキは大きなものは全長150cmに達する大型藻であり、又匍匐枝から翌年の直立体を出す所の多年生海藻であるが、純群叢を作る傾向が強い。それは一つには匍匐枝が基盤を密に被覆して、他の海藻の混生を困難にしている爲と思われる。そこで同一の階層群落を作る海藻として混生して来るものは後述のウミトラノヲ位のものである。

ヒジキ群叢の下層群落としても特記すべきものはなく前述隣接群落を作るイワヒゲ、イシゲ、イロロ、ハバノリ、ビリヒバ、ツノマタ、フクロノリ、カゴメノリ等がヒジキ群叢との境界附近に僅かに混生するのみで、その生育も極めて不良である。ヒジキの体上に附着する海藻は少く、地域的にマタザキクロガシラが相當密に着生するのを見受ける他、フクロノリが往々見られる程度である。

D. ウミトラノヲ群叢 ヒジキと同高混淆群叢を作る唯一の海藻はウミトラノヲ *Sargassum Thunbergii* (MERT.) O. KUNTZE. であるが、これも最上層は純群叢を作る傾向が強い。ウミトラノヲはヒジキと違って匍匐枝はないが、円盤状根から短い主軸を出してその頂端に多くの主枝をつけ、その基部に翌年の主枝となる芽を多数もつている所の矢張り多年生の海藻である。

ウミトラノヲ群叢はヒジキと略同じ帯位に繁茂し、その他の外的環境も類似しているが以下の諸点で僅少の相違が認められる。① ウミトラノヲの生育帯はヒジキのそれより余程幅が廣く、特に下限はヒジキより余程低位にあり、一方裂隙等に沿つて相當上方迄附着を見るものである (Fig. 2)。又ヒジキが浅い潮溜りの周縁のみに多いのに對してウミトラノヲは周縁は固より内中央部にも着生する。故にウミトラノヲはヒジキより少しく好水性であると同時に耐乾性もやや強いようである。② 傾斜度に就てはウミトラノヲは急傾斜面に於てもヒジキに見られる程の減少を示さない。③ 波浪についてはウミトラノヲは岩礁奥部で大きな群叢を作り、ヒジキの見られない静穏な所にも生育しているが、周縁部

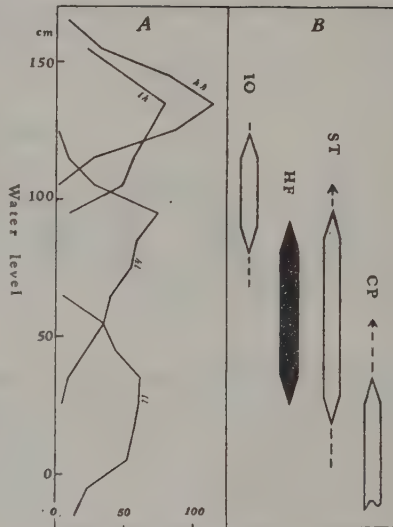


Fig. 2. The correlation between four tidal levels and zones of attachments of *H. fusiforme* and others.

A) Frequency curves of high highwater level, low high w. l., high low w. l. and low low w. l. during a year.

B) Zones of attachments of *Hijikia fusiforme* (HF), *Ishige Okamurai* (IO), *Sargassum Thunbergii* (ST) and *Corallina pilulifera* (CP).

ではヒジキが優先的である。

隣接群落もヒジキの場合と似ているが、下層群落はヒジキの場合よりよく発達している。即ち前述のヒジキの下層に見られるものはすべてよく見られるが、他にカイノリ、トゲイギス等も多く混生している。中でもポリヒバは最も通普に見られるものである。併しこの下層群落はその種類、数量の多い反面生長は一般にやゝ不良である。又この下層群落とウミトラノヲの基部は小動物の絶好の棲所となり、多種多様の小動物が大いに群聚し、特に腹足類、甲殻類が多い。その上これ等の動物の遺骸（特に介殻）、糞、粘質物や砂粒も極めて豊富で、ヒジキの下層が前述のように貧弱であるのと好対照をなしている。

以上の観察から少くもこの調査地域に於てはヒジキの繁殖を阻害する海藻はウミトラノヲ許りであり、それ以外のものはウミトラノヲに伴生して始めて阻害要因に成り得ると考えられる。

I ヒジキ-ウミトラノヲ混濁群叢の組成

A. 混濁群叢組成の検討 第1次調査時以前にはこの禁漁区内の潮間帯にはウミトラノヲが廣く繁茂して強固な群叢を形成し、ヒジキの生育場にも大量混生していたが、中村が1939年以降兩3年に亘りその除去に勉めた結果、混生地域は殆どヒジキの純群叢に變化し第2次の調査で混濁群叢の顯著なものは Fig. 1 の A 地点奥部のみに残されていたに過ぎなかつた。

筆者はヒジキの増殖上特に重要と思われる混濁群叢の組成について研究した。先づ1940年3月中旬混濁及び純群叢中で生長良く、且被度100%を占める地点20箇所を選び、0.5m平方若くはその2又は4倍宛根元より刈取り、生の儘机上に約1時間放置して水切りし

した後秤量して、組成を調べた。下層群落を構成する他の小海藻は無視した。Table 1 Fig. 3 はこれを1m平方に換算して現はしたものである。

Fig. 3 に現れた兩藻の重量組成が負の関係にあることは當然であろうが、これが曲線関係である点は注目される所である

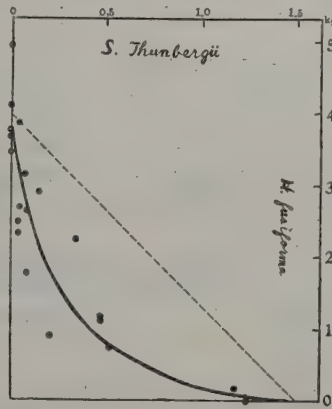


Fig. 3. The correlation between the production of *H. fusiforme* and that of *S. Thunbergii* in the mixed association (from Table 1).

Table 1. The quantity of production, in fresh condition, of the two algae growing in 1m square in the mixed association, March, 1940.

<i>H. fusiforme</i>	<i>S. Thunbergii</i>
4948g	0g
4098	0
3862	37
3761	0
3671	0
3405	0
3131	78
2895	153
2666	48
2647	93
2475	45
2343	37
2250	361
1760	82
1147	474
1125	472
900	206
735	515
164	1186
0	1245

更にこの関係を確かめるため1949年4月17日A地点附

近のウミトラノヲの混生する地域内で特にヒジキ生育帯の上下際と潮溜りを含まぬよう周到な注意を拂つて前回同様の要領で9地点を採取した。この再調査の主眼は前述した所のヒジキの生育乃至着生の特に不良な場所を避けることにはあつた。又この調査ではより確實な数値を得るため乾燥量を秤つた。Table 2, Fig. 4 がそれであるが、これもFig. 3 と同様の曲線となつた。

Table 2. The quantity of production, in dry condition, of the two algae growing in 0.5m square in the mixed association, April, 1949.

<i>H. fusiforme</i>	<i>S. Thunbergii</i>
640 g	3g
610	5
500	10
475	12
440	10
400	10
380	30
330	65
215	145

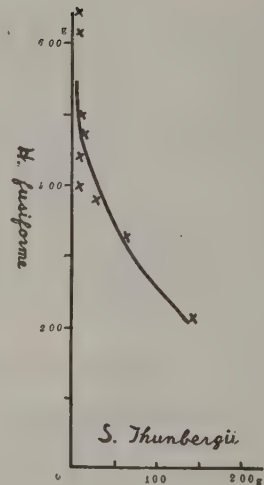


Fig. 4. The correlation between the production of *H. fusiforme* and that of *S. Thunbergii* in the mixed association (from Table 2).

B. 混生曲線の考察 この曲線の由つて来る理由として次の二面が考えられる。① 混生度合が大きい地点程非生物的環境即ち物理化学的な條件が始めから不適當なのではないか。② 混生度合が大きい程相手方の存在による環境の不良化が行われ、それによつて繁殖生育が抑制されるのではないか。

しかし曲線關係の主な原因は前者ではないであらう。何故ならばこのような地域が少くともヒジキにとつて良好な外圍條件をもっていることが次の中村の實驗で證明されているからである。

Table 3. An example on the production of *H. fusiforme* showing the effect of the weeding (from Nakamura).

Before weeding		After weeding	
December, 1938	6.12kg	December, 1939	9.83kg
March, 1939	9.56	March, 1940	17.29

Table 4. The quantity of production, in fresh condition, of *H. fusiforme* per 1m square in the closed pure association of it.

December, 1939	March, 1940
11.19 kg	19.80 kg
8.13	16.39
7.35	15.05
6.95	14.69
5.55	13.62
Mean 7.83 kg	Mean 15.91 kg

除藻効果の實驗 中村⁴⁾ は1938年12月と翌春3月、特に試験区域を定めて、1m 平方のヒジキの着生量を生鮮で秤量し、1939年春その附近のウミトラノヲを主体とする雑藻を除去し、翌年同時期に再び着生量を調査した。その發表數字は Table 3 の通りである。この數字だけでもこのような地域がヒジキにとつて好條件を具備していることがわかるが、どの程度の好條件かはこの實驗だけでは明か

でない。所が筆者の調査でこの点が確められた。即ち好都合なことに筆者は除藻後の兩時期

にヒジキ純群叢の着生量を測定しているのである。Table 4 がそれであるが、これ等の地点は何れも生長度の測定によつて生育の良好なことが確められており、而もウミトラノヲ等の雜藻は殆ど含まれていない。中村の測定値は兩時期に於て、これら純群叢の平均着生量を遙かに上廻り、最良地点に亞ぐ値である。

そこで曲線關係の存在する原因は主として後者即ち相手方の存在による環境の不良化であり、相互の繁殖生長が抑制される面、いわば兩藻の斗争によると思われるのである。

- 1) C. 混生群叢に於る争闘の考察 茲で兩藻の混生による環境不良化の様相について少しく考察してみたい。結論からいえば争闘の様相は次の2項に要約される。① 混生地域は薄生である。② 群叢は時と共に純粹化する傾向がある。

混生地薄生の現象とは双方の勢力が拮抗している場所程直立体の密度が小さいことが認められることで、これは單なる觀察だけでも略明かである。筆者は殘念ながら數量的な調査資料を持たないが、長谷川¹⁾の調査によつて實驗的證明がなされていることを指摘したい。即ち長谷川が筆者の既報²⁾した所に倣ひ、北海道道南地方茂辺地附近のヒジキとホンダワラ類(主としてウミトラノヲ、フシズデモク)の混生關係を直立体の本數を以て調べた所によると、これも筆者の重量測定の場合と同様な曲線となつた。この事實は勢力拮抗地点に於ける量の減少は生育の低下よりも直立体そのものの減少を意味しているといえる。

併し兩藻が互に生育を阻害し合つている状態も見られるのであつて、例えば冬春季混生群叢に於て兩藻の何れか一方が特に優占している場合、弱勢の方は大部の個体が貧弱になつている。又双方の勢力が略拮抗しているような場合は薄生ながらも兩勢力の境界が略明かで、小集團が交錯して棲み分けている場合が多いが、仔細に觀察すると夫々相手方の勢力圏内に根部やいぢけた直立体を見出すのである。これらのいぢけたものは争闘の結果辛うじて残つたものと見られ、一般に争闘の進行と共に兩勢力の区劃が明瞭になつて来る。即ち群叢は次第に純粹化するといえよう。そして兩藻共に多年生根部を有することから、この更行は單に或年度内だけでなく年の経過にも伴うものと想像される。

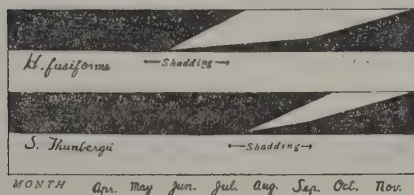


Fig. 5. The Prosperity and the decay of *H. fusiforme* and *S. Thunbergii*.

1cm前後の大きさで過し、10月頃から盛に成長する。一方ウミトラノヲはヒジキより1月余り遅れて胚胞子を放出し、その後舊年度の主枝は徐々に脱落するが、その前に既に新年度の主枝が伸長を開始しており、胚胞子に由來する芽と共に秋季盛に成長する。このように成熟の時期がづれて、而も成長期が一致していることは争闘を烈しくする一因と見られる。

さて小浜ではヒジキは5~7月頃胚胞子を放出して直立部が脱落する一方、匍匐枝から新年度の幼葉を發生する。この頃ウミトラノヲは未だ成熟前で極めて旺盛であるからヒジキの繁殖を大いに阻害すると考えられる。須藤⁷⁾によればヒジキの胚胞子が肉眼的に成長するのは秋季であるがこれは小く、繁殖は主として匍匐枝によることである。所で匍匐枝から出た芽は夏を

更に前述のウミトラノオの下層群落並びに動物群聚は生存斗争の面に於てヒジキの匍匐枝に對應してその進出を阻害する一要因と考えられる。以上の早期の争斗の間に混淆群叢の密度は急速に縮小されるのであろう (Fig. 5)。

Ⅲ 除藻効果の解剖

前述の通り中村及び筆者の實驗結果の統合によつて或混淆群叢でウミトラノオを完全に除去すれば翌年にはヒジキの生産は略極限量に達することがわかつたが、その生産増大の内容を簡単に解剖して見よう。

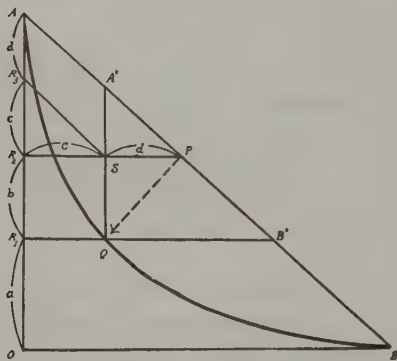


Fig. 6. The analysis of the effect of weeding.

Fig. 6 に於て曲線AQBは或年n年度の争斗の末期に於ける兩藻の混生組成曲線でOA及びOBは夫々兩藻の極限生産であるとする。この際若し兩藻間に争斗がなければ混生組成は直線ABとなる筈である。n年末期に曲線AQB上の一点Qなる組成を示した一地点は若し當初から争斗がなければA'B'上の一点Pの組成である筈であるそこで生産力という点から見るとこの地点の全生産力は次の4小生産力a, b, c, dの合成力である。即ちaはn年末期に存在するヒジキ全量OR₁を生産した小生産力であり、bは同じくウミトラノオの阻害によつて失われたヒジキR₁R₂を生産し得る

徒費された小生産力である。又cは同じく存在するウミトラノオR₂Sを生産した小生産力であり、dは同じくヒジキの阻害で失われたウミトラノオSPに相當する徒費された小生産力である。

n年末期には小生産力bとdは環境の不良化によつて消費されたわけであるが、そこでウミトラノオを除いてしまえばその翌年n+1年毎にはすべての小生産力が皆ヒジキの量となつて發現されてOAなる極限量に達するのであろう。

Ⅳ ヒジキ増産の一方法

既存のヒジキ漁場に於てその増産を圖る最も簡単な方法はウミトラノオとの混淆群叢をヒジキの純群叢に變えることである。春季ヒジキの採取された後はウミトラノオを認め易いし、又ヒジキの繁殖期前に當るからこの頃にウミトラノオを下層群落と共に除去すればよいが、この際ヒジキの匍匐枝を残すことに充分注意しなければならない。更に完全に期するにはウミトラノオの成熟期前にヒジキの生育帯を少しく離れた所までウミトラノオを除去してその胞子の放出、侵入を阻止すればよいであらう。

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1948年夏季に於ける中海（島根縣）の プランクトンに就て*

千葉 卓夫

On the plankton of Nakano-umi in Summer, 1948.

Takuo CHIBA

Nakano-umi is a rather large brackish lake, situated on the coast of Japan Sea and surrounded by the Simane Peninsula and Yomigahama Peninsula. This lake is connected with the Miho Bay by Nakae canal and with the lake Sinji by Magata canal. The reserch of Nakano-umi was made in the summer, 1948. Collection of the plankton was made at 11 stations as showing in the Fig. 1. The species of plankton have been found 59. Zooplankton is almost equal to phytoplankton in number. Among phytoplankton, Diatoms are abundant, 22 species have been found. Especially such as *Thalassiothrix Frauenfeldii*, *Chaetoceras didymus*, *Chaeto. decipiens*, *Chaeto. danicus* are dominant in Diatoms. Protozoa and Copepoda are very important in Zooplankton. *Oithona similis*, *Temora turbinata*, *Calanus spp.*, are dominant in Copepoda. *Ceratium spp.* and *Tintinnopsis spp.* are dominant in protozoa. Considering from the occurrence of the plankton, the Red-tide seems to be caused by *Chaetoceras spp.* at Nakano-umi.

I 緒 言

中海に關する研究報告には既に羽田 (1939), 畑 (1948), 倉茂 (1934), 島根縣及鳥取縣水産試験場 (1949) 等がある。然しプランクトンに就ては倉茂の中海の赤潮に關するものの外余り見るべきものがない。筆者は1948年8月中海の湖沼調査を行ふ機會を得たので其の結果を報告する。湖沼條件については本所の松井, 赤築の報告が豫定されているので茲には記載を省略し, プランクトンに就て論ずることにする。この調査では米子, 美保關附近の水域のプランクトンは採集しなかつたので該区に就ては次の機會に譲る。觀測採集には發動機船を利用し, 第1圖に示す11地点でプランクトンネット (No. 5, 長さ1米, 口徑 30 cm) による垂直採集を行い, 10% フォルマリンで固定し, 教室で檢鏡した。この報告を草するに當り採集調査を援助された小林歌男氏始め, 増殖學科學生諸君に, 又便宜を與えられた島根縣水産試験場に深甚の謝意を表する。

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Fig. 1. Showing the stations of sampling.

Ⅱ ブランクトン (Table 1.)

1. 植物性プランクトン 植物性プランクトンを構成している主なる種類は硅藻類、藍藻類、緑藻類で、総出現種数 24 を検出したが、其の中硅藻類が 22 種で、出現プランクトンの殆んど大部分を占めている。硅藻類中 *Thalassiothrix Frauenfeldii*, *Chaetoceras didymus*, *Chaeto. decipiens* が量的に多く、次いで *Rhizosolenia semispina*, *Chaetoceras neapolitanum*, *Chaeto. danicus*, *Eucampia zoodiacus*, *Coscinodiscus excentricus*, *Haemiaulus Hauckii*, *Leptocylindrus danicus*, *Navicula* sp. が普通に検出され、*Bacteriastrum varians*, *Skeletonema costatum*, *Biddulphia sinensis*, *Climacodium biconcavum* 等が僅か見出された。以上の種類の中沿岸性プランクトンの *Thalassiothrix nitzschoides*, *Thal. Frauenfeldii*, *Chaetoceras didymus*, *Eucampia zoodiacus*, *Haemiaulus Hauckii*, *Bacteriastrum varians*, *Nitzschia seriata* の多くは境水道 St. 4 より St. 9 の水域に分布し、馬潟水道寄りの St. 10 及び St. 11 には *Chaetoceras didymus*, *Chaeto. decipiens* が出現したに過ぎない。温帯外洋性プランクトンで出現したのは、*Chaetoceras neapolitanum*, *Coscinodiscus excentricus*, *Climacodium biconcavum*, *Biddulphia sinensis* 等である。勿論外洋性プランクトンの分布は中海でも潮流の影響に大きく左右され、St. 10 及 St. 11 の矢道湖の注入水による低鹹度水域には出現率が低く、何れも中海全水域には及ばないようである。中海の赤潮に関しては倉茂 (1934) が *Chaetoceras spp.* に依る硅藻赤潮を報じたが、今度の調査でも *Chaetoceras decipiens*, *Chaeto. didymus*, *Chaeto. neapolitanum* が饒産することから、夏季之等の種が、湖沼及び気象条件により大増殖を爲し、赤潮発生の可能性が充分考えられる。

2. 動物性プランクトン 動物性プランクトンの組成は稍々複雑で出現總数は35種で、原生動物、橈脚類、輪虫類、毛顎類、被囊類及び各種幼虫等から成り、原生動物及び橈脚類が主体を爲して、輪虫類、被囊類、毛顎類は出現種数も數量も貧弱である。原生動物は12種出現したが、主なものは *Ceratium tripos*, *Cerat. furca*, *Cerat. fusus*, *Tintinnopsis aperta*, *Tint. radix*, *Tint. nordguisti* 等で、其の外 *Noctiluca scintillans*, *Sticholonche zanclea*, *Peridinium divergens*, *Pyrophacus horologium* 等が僅か出現した。橈脚類では9種検出され、原生動物に次いで出現種数が多いが、量の点では原生動物に遠く及ばない。橈脚類中重要な種は *Oithona similis* で猶ほ暖海性プランクトンの *Temora turbinata*, *Calanus vulgaris*, *Calanus minor* が之に次ぎ、汽水産の *Limnocalanus sinensis* Poppe var. *tenellus* Kikuchi が St. 1 及び St. 11 に多く見られた。又 *Candacia pachydactyla* も稀に検出された。葉脚類では *Evadne tergestina*, *Penilia Schmackeri* が St. 1, St. 2, St. 6, St. 7 に出現した。輪虫類では僅か一種のみで、この *Brachionus angularis* は時期により甚だしく増殖する種で、低鹹度汽水産として知られているものであるが、この調査には極く僅か出現したに過ぎない。毛顎類では *Sagitta* sp. が出現し、被囊類では *Fritillaria haplostoma* が稀に検出された。幼虫ではアカガヒ及びホトギスガヒの幼虫が多く、亦稀にカキの *Post larva* も出現した。動物性プランクトンの中 *Evadne tergestina*, *Penilia Schmackeri* は元來暖流系のプランクトンとして、九州沿岸、日本海、及び瀬戸内海に廣く分布する種であるが、黒潮より低鹹度の中海に出現することはこれ等の種の適應性の強いことを示し、一方低鹹性の *Limnocalanus sinensis* Poppe (= *Sinocalanus sinensis*) は隣接する矢道湖に夏季産する種であるが、矢道湖より遙かに鹹度が高い中海にも出現することは注目される。動物性プランクトンの赤潮發生に就ては、日本海沿岸によく現れる鞭藻赤潮を惹起する *Noctiluca scintillans* の出現率が甚だしく低いことから、中海の赤潮が鞭藻類に原因することは恐らくあるまいと考えられる。其の外原生動物では *Tintinnopsis* spp. が多く出現するが、之等の種は底棲性のもので赤潮を惹起し得ない。亦 *Acanthometron* sp., *Peridinium* sp., *Sticholonche zanclea* も赤潮形成に關係する生物と考えられるが、之等の種の出現潮度の低いことから赤潮發生の可能性は低い。 *Ceratium furca* は岡村 (1903) が東京灣の赤潮生物の中の一つとして報告したものであるが中海に於ては特に *Ceratium fusus*, *Cerat. furca*, *Cerat. tripos* 等の出現率が高いことから動物性プランクトン中では上述の種が赤潮形成に大いに關係するものと考えられる。

Ⅲ 摘 要

1. 植物性プランクトンは總數24種で中22種は硅藻類が占めている。出現量の多いのは *Thalassiothrix nitzschoides*, *Chaetoceras didymus*, *Chaeto. decipiens* である。

2. 動物性プランクトン總數35種で、其中重要位置を占めるものは原生動物、橈脚類である。原生動物12種、橈脚類9種を検出したが原生動物は量的にも大である。

3. 動物性プランクトン中重要種は *Ceratium* spp., *Tintinnopsis* spp., *Oithona*

similis, *Temora turbinata*, *Calanus spp.* 等である。

4. 中海に於ける赤潮發生に就ては動物性プランクトンによる赤潮は *Ceratium spp.* を除いては考えられない。

5. 植物性プランクトン特に *Chaetoceras spp.* による硅藻赤潮は湖沼及び氣象條件によつてはその發生の可能性が視われる。

6. 中海プランクトン組成は対馬暖流系のものと宍道湖の低鹹度性のものととの混合によつて成立していると見られよう。

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Table 1. Showing the occurrence of plankton

Station		1	2	3	4	5	6	7	8	9	10	11
Date, Aug. 23, 1948												
1	<i>Thalassiothrix frauenfeldii</i> (Grun) Cl&Gr.	C	C	CC	CC	C	C	C	C	C	C	C
2	<i>Thalassiothrix nitidissima</i> Grunow	R	R	R	+	+	+	+	+	+	+	+
3	<i>Rhizosolenia semispina</i> Grun	+	+	+	+	+	+	+	+	+	+	+
4	<i>Rhizo. imbricata</i> var. <i>Shrubsolei</i> (Grev.) Schröder	+	+	+	+	+	+	+	+	+	+	+
5	<i>Coscinodiscus excentricus</i> Ehrenberg	+	+	+	+	+	+	+	+	+	+	+
6	<i>Eucampia zodiacus</i> Ehrenberg	+	+	+	+	+	+	+	+	+	+	+
7	<i>Coscinodiscus janishii</i> Ehr.	+	+	+	+	+	+	+	+	+	+	+
8	<i>Leptocylindrus danicus</i> Cleve	+	+	+	+	+	+	+	+	+	+	+
9	<i>Nitzschia seriata</i> Cleve	+	+	+	+	+	+	+	+	+	+	+
10	<i>Haemialus Hauckii</i> Grun	+	+	+	+	+	+	+	+	+	+	+
11	<i>Navicula spp.</i> Lauder	+	+	+	+	+	+	+	+	+	+	+
12	<i>Bacteriastrium varians</i> (Grev.)	+	+	+	+	+	+	+	+	+	+	+
13	<i>Skeletonema costatum</i> (Grev.)	+	+	+	+	+	+	+	+	+	+	+
14	<i>Biddulphia sinensis</i> Grev.	+	+	+	+	+	+	+	+	+	+	+
15	<i>Climacodium biconcavum</i> Grev.	+	+	+	+	+	+	+	+	+	+	+
16	<i>Melosira Borrevi</i> Grev.	+	+	+	+	+	+	+	+	+	+	+
17	<i>Nitzschia longissima</i> Rolfs	+	+	+	+	+	+	+	+	+	+	+
18	<i>Grammatophore sp.</i>	+	+	+	+	+	+	+	+	+	+	+
19	<i>Chaetoceras neapolitanum</i> Schröder	+	+	+	+	+	+	+	+	+	+	+
20	<i>Chaeto. didymus</i> Ehr.	+	+	+	+	+	+	+	+	+	+	+
21	<i>Chaeto. decipiens</i> Cleve	+	+	+	+	+	+	+	+	+	+	+
22	<i>Chaeto. danicus</i> Cleve	+	+	+	+	+	+	+	+	+	+	+
23	<i>Trochiscia Clevei</i> Lemm.	+	+	+	+	+	+	+	+	+	+	+
24	<i>Anabaena Flos-aquae</i> (L.) Jorg.	+	+	+	+	+	+	+	+	+	+	+
25	<i>Ceratium massiliense</i> (Gourr.) Müller	+	+	+	+	+	+	+	+	+	+	+
26	<i>Cerat. tripos</i> Dajardin	+	+	+	+	+	+	+	+	+	+	+
27	<i>Cerat. furca</i> (Ehr.)	+	+	+	+	+	+	+	+	+	+	+
28	<i>Cerat. fusus</i> Brandt	+	+	+	+	+	+	+	+	+	+	+
29	<i>Tintinnopsis radix</i> (Imhof.)	+	+	+	+	+	+	+	+	+	+	+
30	<i>Tintinnop. aperta</i> Brandt	+	+	+	+	+	+	+	+	+	+	+

Table 1. continued

[illegible]

魚類プロテアーゼに関する研究 (第2報)

鰺胃プロテアーゼに及ぼす水素イオン濃度及び温度の影響並びに魚類の胃液の水素イオン濃度に就て^{*)}

藤井 實・富田 輝雄・廣高 浩二・江良 至徳

Studies on the Protease of Fishes (2).

The Influence of Hydrogen Ion Concentration and Temperature on the Proteolytic Enzymes of Sardine-stomach, and the pH of Stomach-juice of Fishes.

Minoru FUJII, Teruo TOMIDA, Koji HIROTAKA and Shitoku ERA

We obtained results as follows.

- 1) The optimum pH of the proteolytic enzyme in the stomach of sardine is about pH 7.5-8.3 and the optimum temperature is about 35 C.
- 2) The activity of this enzyme is completely destroyed by heating of 92 C for 6 minutes.

The pH of stomach-juice of fishes such as red-sea-bream, puffers, wrasses, black-porgy, common-sea-bass, rock-cod and eel is neutral or a little alkaline, (pH7-8); the intestines-juice is considerable alkaline- (pH 7.5-8.3).

魚類胃プロテアーゼに関する従来研究報告^{1) 2)}に依ると、その至適 pH は何れも 3 ~ 4 附近にあり、至適温度は魚種により異なるとされている。然るに著者等の実験に依れば其の作用力は酸性側に於けるよりもアルカリ側に於て著大であることを知つたので此の点に關し新鮮真鰺の内臓組織及びそのアセトン・エーテル処理粉末試料を使用して検討を行い、且其れに關連して胃液及び腸液の pH を各種生魚を使用して検討したのでその結果を報告する。

實 験 の 部

測 定 方 法

アミノ態窒素 : ミクロバンスライク器を用いて測定

非蛋白態可溶性窒素 : 反應液を除蛋白して得た澄明溶液中の全窒素量で示す。

非アミノ態可溶性窒素 : 非蛋白態可溶性窒素よりアミノ態窒素を差引いたものを以て表わすものとする。尙今後使用するカゼイン液はカゼインを苛性ソーダで中和溶解し pH7 と

* 水産講習所研究業績番号 第47号

したものである。

(1) 至適水素イオン濃度に就いて

試料として粉末試料及び新鮮胃を使用した。新鮮胃の場合例えば約 21.5g を珪砂で播碎し水で浸出し遠心分離を行つて組織片を出来るだけ除去し浸出液約 60cc を得、その 5 cc を試料とした。結果は第 1, 2 表及び第 1, 2 圖の示す如くである。

Table 1. (Sample : Powder. 0.05g. Time and Temp. of Reactn., 65hrs. 35°C)

pH	1.4	2.4	3.4	4.0	5.4	6.0	6.8	8.0	8.3	8.8
Amino-N. (mg.)	—	0.0156	0.0550	0.0550	0.1386	0.2362	0.2403	0.2979	0.4895	0.3454
Non-amino-soluble-N. (mg.)	0.0080	0.0080	0.0534	0.0498	0.0637	0.1351	0.1400	0.1601	0.1601	0.1542
Non-protein-soluble-N. (mg.)	0.0080	0.0236	0.1089	0.1048	0.2023	0.3713	0.3803	0.4580	0.6496	0.4996

Table 2. (Sample : Extracted Juice from Fresh Sardine Stomach. Time and Temp. of Reactn., 39 hrs. 35°C)

pH	4	5	7	7.5	8.4
Amino-N. (mg.)	0.0919	0.1034	0.2125	0.2215	0.2470
Non-amino-soluble-N. (mg.)	0.0495	0.0618	0.1879	0.1971	0.1296
Non-protein-soluble-N. (mg.)	0.1414	0.1652	0.4004	0.4186	0.3766

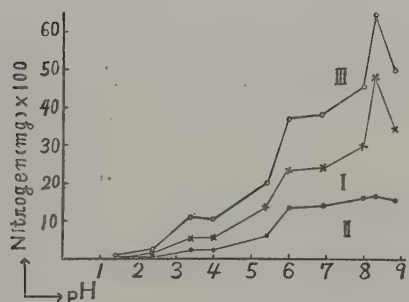


Fig. 1. Optimum pH of the proteolytic enzyme in the sardine-stomach. (powder)
I: Amino-nitrogen.
II: Non-amino-soluble-nitrogen.
III: Non-Protein-soluble-nitrogen.

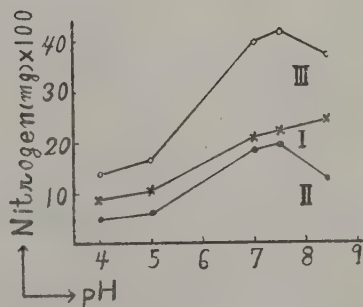


Fig. 2. Optimum pH of the proteolytic enzyme in the sardine-stomach. (fresh)
I: Amino-nitrogen.
II: Non-amino-soluble-nitrogen.
III: Non-protein-soluble-nitrogen.

更に比較のため新鮮な鯖の胃約 1g を珪砂で播碎したものを試料とした結果は第 3 表及び第 3 圖の示す如くである。

魚類プロテアーゼに関する研究 (3)

Table 3. (Sample: Fresh Tissue of Mackerel-stomach 1g. Time and Temp. of Reactn., 67 hrs., 35°C)

pH	1.4	2.4	3.6	4.5	5.8	6.7	7.6	8.0	8.3	8.8
Amino-N. (mg.)	0.0553	0.0604	0.0722	0.1379	0.1857	0.1953	0.2202	0.2425	0.2702	0.2094
Non-amino-soluble-N. (mg.)	—	0.0664	0.0712	0.1421	0.1279	0.1494	0.1537	0.1502	0.1226	0.0642
Non-protein-soluble-N. (mg.)	0.0553	0.1268	0.1434	0.2800	0.3136	0.3447	0.3739	0.3927	0.3928	0.2736

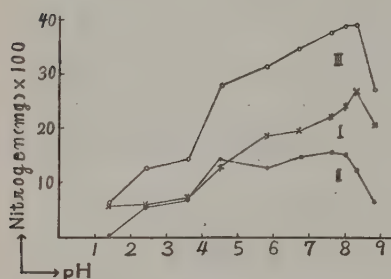


Fig. 3. Optimum pH of the proteolytic enzyme in the mackerel-stomach. (fresh)

I: Amino-nitrogen.
II: Non-amino-soluble-nitrogen.
III: Non-protein-soluble-nitrogen.

以上の諸表及び圖より明かな様に胃プロテアーゼに依り生成されたアミノ態窒素は鰯鯖のいづれに於ても pH 8.3 附近で最も多く非アミノ態可溶性窒素は鰯に於て pH 7.5~8.3, 鯖に於て pH 7.6~8.0 の範囲で著しく増大している。そして兩者共微酸性の pH 5~6 に於ても相當高い値を示している。又非蛋白態可溶性窒素はいづれも pH 7.5~8.3 の範囲に於て最大値を示している。従つて至適水素イオン濃度は、pH 7.5~8.3 の範囲内にある。

(2) 至適温度及び破壊温度に就いて

石田氏⁹⁾ はブダイ, キヌベラ, クサベラ等の肝臓のアミラーゼに就き研究し, その至適温度は作用時間に従つて値にずれがあるとしている。本實驗は何れも 3~6 時間内で行つたのであるが第 4 表の如き結果を得た。次に沸騰水中に酵素液を漬し酵素液温が 92°C に達してから 2, 4, 6 及び 8 分間置きに之を取り出し直ちに室溫に冷し常法の如くしてアミノ態窒素を測定し第 5 表を得た。

Table 4. (Sample: Powder. 0.02g. Time of Reactn. 3hrs. pH. 8.3)

Temp. (°C.)	15	20	35	40	55~60
Amino-N. (cc)	0.14	0.23	0.48	0.36	0.25

Table 5. (Sample: Powder. 0.05g. Time of Reactn. 4hrs. pH. 8.3)

Time of Heating (min.)	2	4	6	8
Amino-N. (cc)	0.11	0.10	0.07	0.07

第 4, 5 表の結果より至適温度は 35°C 附近にある。又 92°C に 6 分間加熱すれば完全に破壊される。

(3) 魚類の胃液のpHに就いて

Vonk³⁾ 氏に依れば胃液は常時pH4.5~4.7の値を有し食餌により胃が充されるとpHは更に低下しpH2のときペプシンは最も良く働くと。又五味亮一、鳥巢英夫²⁾ 氏等も多数の魚類の胃液に就き研究しいつでも酸性を呈しアカエイはpH5.6で最大、他のものは其れよりも低いpH値を有すると述べている。然るに著者等の実験に依れば胃プロテアーゼの作用は微アルカリ性に於て著しく強大であることを知つたので下記の魚種に就き胃液のpHを検討した。試料としては、死魚は生魚に比し既に生理條件を變化しているわけであるから總て生魚を使用した。即ち海中より釣り上げた生魚を直ちに解剖して東洋濾紙會社製のテストペーパーを胃壁に押し當てて呈色せしめた。比較として腸壁のpHをも檢したがその成績は第6表の示す如くである。更に海水の影響を排除するため生魚を直ちに0.1N塩酸に投入し通氣を行いその死後直ちにpHを測定した所全く同一結果を得た。以上の結果より少くとも之等の魚類は胃液のpH7~8、腸液のpH7.7~8.5と云う條件の下に夫々消化機能を遂行しているものと推察することが出来る。

Table 6. The pH of Fishes-stomach-juice.

Name of Fishes	Conditions	pH	
		Stomach	Intestines
Red-sea-bream (たい)	full	7.5	8.2
	empty	7.4~7.8	8.3
Puffers. (ふぐ)	full	7.5~8.0	8.2
Wrasses (べら)	full	7.6~8.2	8.3~8.4
Black-porgy (ちぬ)	full	7.4	8.1
Common-sea-bass (せいご)	full	7.4	8.4
Rock-cod (めばる)	full	7.6	8.3
Eel (うなぎ)	full	7~7.5	8.0~8.5
	empty	7.5	8.3

總 括

- (1) 鰹胃プロテアーゼの至適水素イオン濃度はpH7.5~8.3の範囲内にある。
- (2) 該酵素の至適温度は35°C 前後にあり、此の温度より高くなると急激に作用力は弱まり92°C 6分間の加熱で完全に破壊される。
- (3) たい、ふぐ、べら、ちぬ、せいご、めばる、うなぎ等の胃液のpHは7~8で腸液の夫は7.7~8.5にある。(尙此の報告の大意は昭和26年11月の農藝化學大會(九大)に於て述べた。

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魚類プロテアーゼに関する研究 (第3報). 鰾幽門垂プロテアーゼの酵素化学的性質に 就いて (其の1)*

藤井 実. 富田 輝雄. 江良 至徳

Studies on the Protease of Fishes (3).

On the Proteolytic and Chemical Characters of the Enzyme in Pyloric Appendage of Sardine (Part 1).

Minoru FUJII, Teruo TOMIDA and Shitoku ERA

We studied on the influence of inorganic acid, salt of HCL and organic solvents to the proteolytic action of pyloric appendage of sardine and on the solubilities of this enzyme to water, and also we calculated the velocity constant for this enzyme. Results obtained are as follows.

- 1) The proteolytic action of preparations made from pyloric appendage of sardine is completely inhibited at lower than pH 1.4 by adding inorganic acid such as sulphuric or hydrochloric acid.
- 2) The proteolytic activity of this enzyme is inhibited proportional to the concentration of salt such as NaCl or KCl, but 40 % activity is remained against the concentration of 30 % NaCl.
- 3) The organic solvent such as ethylalcohol or acetone inhibites the activity of this enzyme, yet the existence of 30 % solvent in reaction solution remains 30 % activity of this enzyme.

The activity of the immersed tissue, in acetone of various concentrations from 90 to 100 % for less than 5 minutes, remains perfectly.

- 4) The velocity constant for this enzyme conforms to the reaction of the first order for short time-less than 180 minutes-, but it decreases in more than 180 minutes.

鰾幽門垂プロテアーゼの無機酸, 無機塩類, 有機溶媒等により受ける影響, 水に対する溶解度合い並に反応速度恒数等に就き実験を行つたのでその結果を報告する。

(1) 無酸機の影響に就いて

硫酸の影響: 粉末試料 0.05g を含む反応液に $N/10$ 硫酸液を 1, 2, 4, 6, 8 及び10cc加えてPHを種々變化せしめプロテアーゼ作用力を測定した結果は第1表の如くである。

*) 水産講習所研究業績番号 第56号

Table 1. The Influence of Sulphuric Acid on the Protease
(Sample : Powder 0.05g, Time and Temp. of Reactn. 24hrs, 35°C)

Added ^N / ₁₀ H ₂ SO ₄ (cc)	1	2	4	6	8	10
PH in Reaction Sol.	4.7	4.2	3.4	2	1.6	1.4
Amino-N. (cc)	0.09	0.06	0.06	0.03	0.03	0

尚塩酸の影響に就いて硫酸の場合と同じ方法により実験を行つたが全く同じ結果を得た。

(2) 無機塩の影響に就いて

(A) 食塩の影響

魚肉の塩蔵或は塩辛の製造等に於て防腐の目的を以て多量の塩が添加されるが、之が魚体のプロテアーゼ或は魚肉蛋白分解の目的で添加されたプロテアーゼに對する影響に就いては未だ定量的な報告を知らない。よつて我々は反應液が夫々1, 5, 10, 15, 20, 25及び30%の濃度となる様に化學的純粹な食塩を添加して其の影響を検討し、第2及び3表の結果を得た。

Table 2. The Influence of NaCl on the Protease.
(Sample: Powder. 0.05g. Time and Temp. of Reactn. 30hrs. 35°C, PH8.3)

NaCl (%)	0	5	10	15	25	30
Amino-N. (cc)	0.97	0.61	0.51	0.49	0.38	0.38
Activity (%)	100	63	53	51	39	39

Table 3. The Influence of NaCl on the Protease.

NaCl (%)	0	1	10	20	30
Amino-N. (cc)	0.62	0.56	0.42	0.33	0.27
Activity (%)	100	90	68	53	43

(B) 塩化カリの影響

更に塩化カリを 5, 10, 15, 20, 25 及び 30%の濃度になる様に添加した場合の結果は第4表の如くである。

Table 4. The Influence of KCl on the Protease.
(Sample: Powder 0.02g. Time and Temp. of Reactn. 41hrs., 30°C, PH 8.3)

KCl (%)	0	5	10	15	20	25	30
Amino-N. (cc)	0.41	0.26	0.23	0.23	0.20	0.18	0.17
Activity (%)	100	63	56	56	49	44	41

第2, 3 及び4表の示す如く食塩, 塩化カリの濃度が1%程度の場合プロテアーゼ作用力は殆どその影響をうけないが5%添加では約40%, 10%添加に於ては約50%の作用力

魚類のプロテアーゼに関する研究 (2)

の減少を來す。しかもそれ以上25~30%の添加に於ても尙40%程度の作用力を維持している。従つて塩蔵肉や塩辛製品の如き食品に於ては相當高濃度の食塩の添加にも拘らず尙相當のプロテアーゼ作用力を保持しているものと考えられる。

(3) 有機溶剤の影響について

(A) エチルアルコールの影響

エチルアルコールの諸濃度下に於けるプロテアーゼの作用力を検討した。即ち第5表の如きアルコール濃度に於て反應を行わしめ、その作用力を測定したがその際生成される非蛋白態可溶性窒素の量を以て作用力を示すものとした。

Table 5. The Influence of Ethyl-alcohol on the Protease.

(Sample: Powder, 0.02g, Time and Temp. of Reactn. 44hrs. 35°C, PH 8.5)

Alcohol (%)	0	1	3	5	10	15	20	25	30
Non-Protein-soluble-N. (cc)	0.282	0.272	0.255	0.238	0.204	0.153	0.119	0.093	0.080
Activity (%)	100	96	90	84	72	54	42	33	28

此の表より明かな様にアルコールが10%前後の場合無添加に比して70%の作用力を有するが15%の添加に於ては作用力は半減し25~30%の添加により作用力は約30%に落ちる。

(B) アセトンの影響

組織の乾燥粉末製剤を造る場合、アセトン處理を行つてゐるのであるが、アセトンの反應液中に於ける濃度や酵素素材との接觸時間が酵素の作用力にあたえる影響について明確な報告がないので此等の点を追及した。第6表は反應液中のアセトンの濃度の影響を示し、第7表は適當の大きさに切断した生の酵素素材を各種濃度のアセトン液に5分間浸漬振盪し直ちにアセトン液を分離した後組織を搗碎し反應液中に添加し一定時間後作用力を測定した成績である。アルコールの場合と同様にバンスライク器によるアミノ態窒素の測定値は過大となるので非蛋白態可溶性窒素量を以て作用力を示すものとする。

Table 6. The Influence of Acetone on the Protease.

(Sample: Powder, 0.02g, Time and Temp. of Reactn. 22hrs. 35°C, PH. 8.0)

Acetone (%)	0	1	3	5	10	15	25	30
Non-Protein-soluble-N. (cc)	0.188	0.154	0.138	0.137	0.124	0.120	0.104	0.057
Activity (%)	100	82	73	73	66	64	55	30

Table 7. The Activity of the Immersed Tissue, in Acetone of Various Concentrations for 5 Minutes.

(Sample: Fresh Material 1g, Time and Temp. of Reactn. 18hrs, 35°C, PH 8.3)

Acetone (%)	0 (Control)	100	95	90	85	80	75
Amino-N. (cc)	0.310	0.309	0.309	0.308	0.199	0.163	0.128
Activity (%)	100	99.7	99.7	99.4	64.2	52.6	41.3

第6表の示す所に依れば反應液中のアセトンの濃度が増加するにつれて作用力は阻害せられ10~15%の添加に於て約60%, 30%濃度に於て約30%に落ちる。又第7表の結果より5分間のアセトン浸漬後直ちに溶剤を除去すると90~100%アセトン液を使用した場合には殆どその影響はないが85%以下の濃度で處理した場合に於ては作用力は急激な低下を來す。此の低下の程度はアセトンの濃度の低下と共に大となつていたので之は恐らくアセトン溶液中の水部に溶出するプロテアーゼが水部の割合の大となるにつれて急激に増大する結果生ずる低下であらう。従つて乾燥粉末製剤を作る場合アセトン液の濃度90%以上を用い、5分間以内の浸漬處理を行えば作用力の低下を殆んど免れることが出來よう。

(4) 該酵素の抽出法に就いて

以上の諸實驗に於ては出来るだけ生体の條件に合致するように生体組織或はそのアセトン、エーテル處理粉末試料を用いたが此の酵素の本質に関する知見を得るにはより純粹な状態の酵素試料を得ることが必要である。よつてその抽出に關する諸條件の検討を行つた。

(A) プロテアーゼの抽出量と抽出時間との關係

粉末試料 0.05g に蒸留水を加えて 50cc となし、常溫にて數回振盪し、その混合液より 30, 60, 120 及び 240 分置きに 5cc 宛取り出し之を更にグラフスフィルターにかけその内の固形物を除去した後反應液に添加して作用力を測定した結果は第8表の如くである。

Table 8. The Relation of the Enzyme-quantity to the Extraction-time.
(Time and Temp. of Reactn. 24hrs. 35. C, PH8.5)

Time of Extraction (min)	30	60	120	240
Amino-N. (cc)	0.16	0.20	0.22	0.20

即ち常溫で一時間の抽出により溶出される酵素量は一定値に達する。

(B) 各種水素イオン濃度水溶液に依るプロテアーゼの抽出

甘蔗サツカラゼの如く組織に吸着された酵素は單に組織の搗碎等により水抽出は殆んど出來ない¹⁾。依つて此の種プロテアーゼの水抽出の可否に就いて検討を行つた。粉末試料 0.05g を各種pHの緩衝液で一時間抽出後遠心分離を行い液部と固形部を夫々カゼイン反應液に添加して第9表の如き結果を得た。

Table 9. The Relation between the Water-soluble-protease and the
So-called Absorbed Protease.
(Sample: Powder. 0.05g. Time and Temp. of Reactn. 24hrs. 35°C)

PH	3.5	5.8	8.5	9
Amino-N. (cc) (Liquid-portion)	0.24	0.26	0.33	0.31
Amino-N. (cc) (Solid-portion)	0.03	0.05	0.05	0.04

此の結果より明かな様に溶出された酵素量は全酵素量の約80~90%に及ぶが尙組織に20~10%の量が吸着されている。而して液部の作用力の差異は水素イオン濃度の差異に基くものである。

(5) 該酵素の反應速度恒數について

粉末試料0.1gを水50ccで浸出しその清澄液5cc宛をカゼイン反應液に添加して夫々30, 60, 180, 360及び1200分間反應せしめた後一次反應式に従つて反應速度恒數を求めた。

Table 10. The Velocity Constant Calculated by Means of the Reaction-formula of the First Order. (a=12,3760 mg. Sample: Powder)

Time of Reactn. (min.)	30	60	180	360	1200
Amino-N (mg.) in Reaction-solution.	0.8502	1.6504	4.2510	5.9514	11.6194
$K \times 10^5$	237.2	238.6	233.8	181.6	101.1

次に幽門垂約15gを播碎し、60ccの水を加えて浸出し達心分離を行いその上澄液5ccを反應液に添加して後反應速度恒數を求めた。その成績は第11表の通りである。

Table 11. The Velocity Constant Calculated by Means of the Reaction-formula of the First Order (a=12.3760mg. Sample: Fresh Tissue)

Time of Reactn. (min)	60	90	120
Amino-N. (mg) in Reaction-solution	8.2186	10.2024	10.7692
$K \times 10^4$	181.9	182.2	170.1

以上の結果より反應速度恒數は 180分の如き短時間内の反應に於ては一次反應式に従うようであるが時間の経過と共に減少してくる。之の原因については反應溫度が酵素の失活にあたえる影響や酵素量の關係等が考えられるので之等については検討中である。

總 括

- (1) 鰻幽垂プロテアーゼは硫酸の如き無機酸の添加により pH1.4 以下に於て完全にその作用を阻止される。
- (2) 該酵素は食塩、塩化カリの如き無機塩の添加によりその濃度に従い作用は阻害される割合も大となるが、塩の30%の添加に於ても尙40%程度の作用力を保持する。
- (3) エチルアルコール、アセトンの如き有機溶剤の添加により該酵素の作用力は阻害を受けるが之等溶剤の30%の添加に於ても尙30%の作用力を保持する。而してアセトン濃度90%以上の液で5分間以内に於て浸漬された酵素素材はその影響を殆ど受けない。
- (4) 該酵素の反應速度恒數は 180分 程度の短時間内に於ては一次反應式に従うがそれ以後は時間の経過と共に減少してくる。

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